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May 10, 1923

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Downstream Face of Tirso Dam, Sardinia—Multiple-Arch Structure on Stone Masonry Buttresses

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, *Editor*
FRANK C. WIGHT, *Managing Editor*

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Times Have Changed

From Engineering News, Oct. 7, 1909, p. 391

MR. WILBUR WRIGHT made a notable flight of some 20 miles from the military reservation at Governor's Island, in New York Harbor, on Oct. 4. After rising above the island he proceeded up the Hudson River to about 125th St., passing over all sorts of river craft and over the warships of England, France, Germany, Italy and the United States, assembled for the Hudson-Fulton celebration. The return was made over the same course and he landed at the starting point. The total time of the flight was about 33 minutes. The height at which the machine flew varied from 30 to 300 ft.

Special to The New York Times

SAN DIEGO, Cal., May 3, 1923—The great army monoplane T-2, piloted by Lieutenant Oakley G. Kelly and Lieutenant John A. Macready, landed here today at 12: 26: 56 p.m., Pacific time [3: 26: 56 p.m., Eastern standard time] 26 hours and 50 minutes from the time it left Hempstead, L. I., yesterday afternoon. The distance covered is estimated at more than 2,700 miles.

Able Hands at the Helm

IN THE twenty years or more since the government established its great scientific and technical study laboratory at Washington, the Bureau of Standards, the ideals of science have been the guiding star by which the institution's course was charted. There have been those who believed they saw scientific and technical aims in conflict at the Bureau, and not a little of the passive opposition which the Bureau at times encountered may be traced to such belief. But all the engineering investigation conducted there, however practical, has manifestly been vitalized by the scientific spirit; and we believe that any impartial survey of the Bureau's development will show no conflict, or even rivalry, between the two. Some months ago, when the sure hand of Dr. Stratton relinquished the helm, there was justified apprehension that other purposes might come into control—that his successor might lay a course by another star. The choice of George K. Burgess quiets these apprehensions. It gives assurance that scientific ideals and inspirations will continue in control, supported by a thorough understanding of technical needs. Engineers who have come into direct contact with Dr. Burgess' work at the Bureau feel a distinct satisfaction, moreover, that the future guidance will have the inestimable advantage of ripened experience in the peculiar problems of the great public laboratory no less than in scientific and technological research.

A Novel Dam

EUROPEAN conditions as to labor and material are so different from ours that it is not possible to make comparisons between standards of structural practice. For that reason an American engineer can say of the remarkable Tirso dam now approaching completion in Sardinia only that it would never prove economical in this country. It is, however, a most interesting structure not only because it is by far the highest multiple-arch dam in the world (nearly 70 ft. higher than the Lake Hodges dam, the highest in the United States) but because of the use of stone masonry for buttresses and concrete for the arch face. With masonry costing what it does in the United States such buttresses would probably be prohibitive and even were they possible it is doubtful if their superiority over concrete would be admitted. But the Europeans are more partial to composite structures and doubtless have some good arguments why the masonry buttresses were used.

Over-Ordering Abuses

THE abuse of over-ordering emphasized recently in these pages is not peculiar to the construction industry. It is, to some extent, found in every industry whose nature is such that contracts are placed for future delivery. The Committee of the Department of Commerce on Business Cycles, headed by Owen D. Young, chairman of the board of the General Electric Co., has, in its report of March 1, this year, characterized over-ordering as one of the bad features of inflation periods and recommends forms of contracts that provide financial penalties for cancellation. The committee put it this way: "Contracts for purchase of materials should contain definite and substantial financial penalties for cancellation. It is clearly undesirable that contracts should be considered subject to cancellations except under conditions specified in advance, with such penalties as may be fair to both parties. Insistence on this principle and the inclusion in contracts of substantial penalties for cancellation will tend to prevent duplication of orders, to lessen the tendency to place orders far ahead of immediate requirements, and to prevent speculative buying by men who when they order have no intention of completing the purchase if prices drop."

More Light on Activated Sludge

THAT sewage sludge can be activated without compressed air aëration is the belief of a number of operators of working-scale plants in England which depend wholly upon mechanical agitation and is a growing belief or hope in America. The findings of Dr. Buswell on another page tend to confirm this belief. Some new light is thrown on the old subject of metabolism. It is well known to biologists that protozoa and sphaerotilus organisms thrive with very little oxygen. On finding these organisms dominant in activated sludge the question is naturally raised, does the process really need so much air? Most advances come about by re-examination of previous experiments for possible errors of technique or conclusion. Dr. Buswell disagreed with the Nordell conclusions against mechanical agitation and by analyzing closely the process of changing organic to inorganic matter has come to the conclusion that sewage will in any reasonable treatment get enough oxygen to take care of the "wet burning" process whereby the dead, but fresh, organic material in sludge is ingested and digested into the living stage

again, at which point it is "ripe" and ready to be "harvested." Since it is a short step it requires a minimum of oxygen. Further treatment simply reduces the fertilizer value. Probably the most satisfying outcome of Dr. Buswell's tests are his conclusions that activated sludge treatment differs from the tank-and-filter treatment only in degree of progress toward complete mineralization rather than in kind. From the practical standpoint Dr. Buswell is quite emphatic in stating that the laboratory apparatus used was for experimental purposes to determine factors by isolation or by making certain of them constant rather than to point the way of future plant design.

Special and Universal Standardization

NEWS of the formation of a body to deal with marine standardization, as just reported, makes an interesting addition to the story of the development of standardization methods, and recalls various doubts and misgivings that have existed. Technical standardization until recent years was parceled out into many small specialty fields, apparently each unrelated to any other. Then followed the successful attempt to bring all the work under central control, wiping out the boundary lines between fields, by the establishment of the American Engineering Standards Committee. It was a swing from an extreme to the opposite—from narrowest limitation to vague, formless universalism. Now comes the first sign of a return to an intermediate position, with specialization again claiming its place. Both of the extremes have weaknesses that are more or less obvious. With intensive specialization, the narrowness of objective is (or was) frequently accompanied by narrowness of view, leading to disregard of essential considerations and therefore yielding unsound results. With the wiping out of specialization came loss of aim and vital impulse, so that the results produced were apt to be bloodless. Somewhere between, in some intermediate conditions, there must be a minimum of faults and a maximum of efficiency. It may be that the reestablishment of independent specialty standardization in the marine field will help in bringing us nearer this ultimately desirable adjustment.

Women Engineers in England

WHILE this country can boast a few women engineers, it certainly has not reached the stage of England where, we note from a recent copy of the Manchester *Guardian*, there has been an annual meeting —the first of its kind—of the Women's Engineering Society. They came together at Birmingham University in April with some forty delegates. According to the account, there was a paper by a Miss Partridge, B.Sc., on her practical experience in electrical contracting; another on some considerations of electrical design by a lady who is an associate member of the Institute of Electrical Engineers; and a lecture, with lantern slides, on the development of the woman engineer in France by Madame Laurent, a director of the École Technique Feminin de Paris, which would indicate that in France, too, women are going into engineering work. Mrs. Frank B. Gilbreth, the well-known wife and coworker of the equally well-known American efficiency engineer, was to have spoken but was kept away from the meeting by illness. While we adhere to the feminist view that women are people and that therefore sex is a curious basis for technical society segregation it is obviously our duty to record this latest development.

Charging for Highway Service to Foreign Trucks

ROAD traffic counts in Connecticut indicate that 40 per cent of the net tonnage is carried by foreign trucks. These trucks pay no fee for operating on Connecticut highways. Assuming that the damage to roads is proportional to tonnage carried, the condition is considered to require action. In any event, action has been inaugurated by introducing into the State Legislature a bill imposing a tax on trucks from other states which operate in Connecticut more than a certain few days a year.

There is prophecy in this action of a contingency which confronts all state highway departments. Although few states have now so dense a traffic of foreign trucks as has the state named, it is only a question of time when it will exist in many states. What then is to be the solution? May we assume that there will be an equal interchange of road service which balances all charges of road damages by foreign trucks. Such a complete mutuality of road service between states seems unlikely although we have no sufficient traffic records to furnish proof one way or the other. Are truck operators to pay a tax or license fee in every state of the group in which they operate? There are already several groups of states in which truck haulage is an interstate operation. New York, Connecticut, Massachusetts, and Rhode Island form one group. Another is New York, Pennsylvania, and New Jersey with Maryland and Delaware possible future units. Or instead of control and regulation by separate states, will there be interstate regulation by a federal bureau?

These questions have more than speculative interest. In a very few years they are certain to press hard for an answer. How well prepared are engineers to answer them? It is true perhaps that most state highway officials have estimated the facts, but these estimates are hardly more than educated guesses. There must be a more solid basis of known traffic facts to establish sound policies and practices. To possess this knowledge traffic surveys must be undertaken in enough detail and for a long enough period to disclose information which at present only one or two state highway departments have. The state highway administration of Connecticut aided by the Bureau of Public Roads has taken an admirable lead in determining highway traffic facts. It should be an encouraging example to others.

City and Regional Planning

THE elemental parts of city planning rather than the comprehensive city plan were dominant at the Baltimore Conference on City Planning last week. This was in part due to the many papers relating to Baltimore on the program but it is in keeping with the history of city planning. That is, it has been and largely still is such elements as streets, water supply, sewers, paving, parks and transportation, each as a rule singly and independent of the other, that are planned and not these and other elements of the city planning in relation to each other and the whole. Perhaps this, combined with the inherent difficulties of planning—or replanning —existing city areas is one reason why so much attention has of late been given to regional planning. Experience has shown that even in the unbuilt areas of a city it is difficult to plan comprehensively, at least

with much hope of carrying the plans beyond the paper stage, on account of what might be termed the ossification of the plan of built-up area and lack of co-ordination between the inner and outer area of the city on the one hand and the outlying districts on the other.

This and other things have directed increasing attention to regional planning in the last few years, in the hopes of working in more nearly virgin territory and fixing at least the main trunk and limbs of the skeleton of a plan covering city, suburbs and satellite cities before lines are so fixed as to make co-ordinated regional planning difficult and costly if not prohibitive. Naturally enough, studies of regional planning did not go far before it was seen that some degree of zoning is almost as essential throughout a whole region as within a single municipality. As soon as regional zoning was given detailed consideration it became evident that it presents serious difficulties not found in city zoning due to a multiplicity of local administrative units in place of the single governing body of a city, town or village. These difficulties should not prove insurmountable, but they call for a large and broad-minded co-operation between municipalities, with perhaps county or inter-county and even state direction, as well as for able leadership and competent technical advice.

Counteracting Boom Psychology

WITH the air of one who finds the misfortune of his friends not altogether displeasing, the New York correspondent of the London *Times* reports to his paper that the United States is riding to a financial fall. "The simple truth is," he says, "that what has been described as 'boom psychology' has seized the public. A continually rising stock market, a runaway market in building, in steel and in motor cars, humming factories, labor fully employed at very high wages, the newspapers full of company reports showing enormously increased production in the basic industries, easy money, extravagant expenditure everywhere—these are influences toward excitement which few human beings can resist. All of these are present now in the United States. . . . The last phase of the business cycle has begun. Nobody can tell how long it will continue, because no one can know whether caution will intervene to check a forward movement already too rapid in its pace or whether the recovery presently will bolt, with the bit between its teeth. Of the two alternatives the latter seems the more probable, if only because excessive optimism is the American national vice."

One lone correspondent's view of the business situation would not be very important were it not for the fact that that view is commonly held by a number of people, who do not see that the very prevalence of the view is the protection against the catastrophe they anticipate. If we can only get enough people to have the same worry the contingency they worry about will by that fact be apt not to occur.

It is true that this country is enjoying remarkable prosperity. Every statistical figure for the current year shows unprecedented production, rising wages, increasing sales and import taxes and lowering unemployment. These indices of prosperity are, to be sure, accompanied by rising prices, but so far, at least, this rise has not kept pace with the production and consumption averages, the excess of which over price averages is a fair measure of prosperity. Judging by the history of such booms the curve will go on and up until a sudden and unlooked-for break carries it far below a normal level. It is just such progress that the *Times* correspondent predicts.

This year, however, the business men of this country are better prepared to prevent such an occurrence than ever before. The fall of 1920 is still a horrible memory. That summer, too, all the indices of prosperity were rising, and in the optimism following the depression of war almost every one lost a sense of values and plunged on and on in an orgy of production and price elevation. The inevitable happened—a "buyers' strike," with consequent cancellations, overstocking and a depression which took nearly three years to outlive. Ever since, the lesson of unwisdom has been hammered home. With that lesson in mind, optimism—at least excessive optimism—should have ceased to be an American vice.

There are signs already that those who control affairs are taking heed of the lesson of 1920. Undue expansion is being checked in every business organization, unnecessary building is not encouraged, financiers are opposing the large bond issues for public improvements, the federal government has announced a policy of decreased public works, architects and engineers are advising against projects which can well be withheld. Prices and wages, even, are going up with a slowness indicative of economic necessity rather than with the eager rapidity of 1920. Certainly, the business world is going into the summer with full recognition of the signs in the road. To foresee trouble is the surest way to avoid it.

Nor does there seem to be any reason for those in the construction field to be fearful that a too widespread warning against expansion will result in a too sudden shutting down of construction. There is small danger of that now. Already the prospective work for the coming year is great enough to engage all the men and material that are available. Much more than the normal flow of business for the next few months would swamp the productive capacity of the industry, and cause just the trouble we are trying to avoid. The time has now arrived for the longer view; for an appreciation of the fact that tomorrow's job is nowhere near as important as next year's job and that in the long run it avails nothing to profit greatly for a while if such profiting means losing much more over a long period.

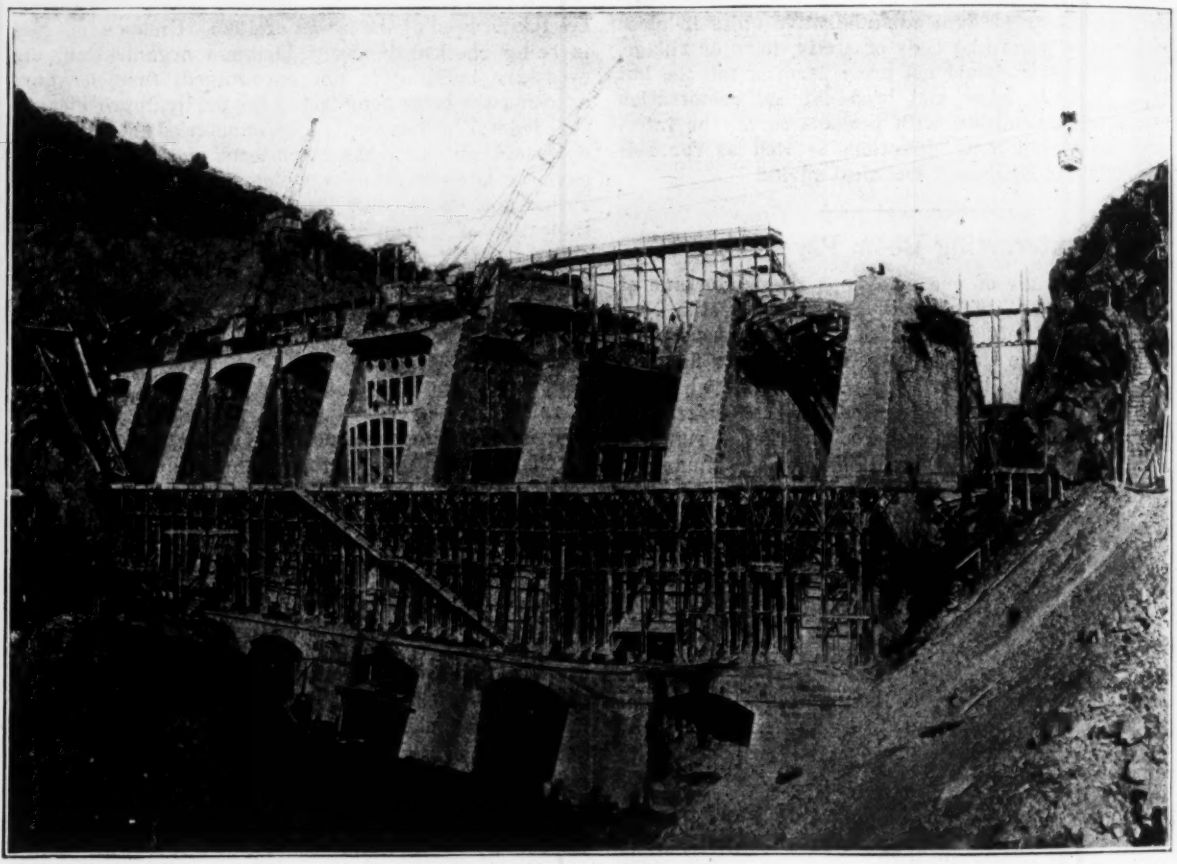
The time has come, too, for the personal application of the general advice against overexpansion and undue prices. The individual counts for much in the control of the business cycle. In all of the suggestions of the Hoover committee, governmental or group action plays a minor part. The burden of smoothing out the curve rests on the collection of individuals. This may seem impractical and idealistic but in reality it is the most practical and materialistic advice in the world. Each individual either in person or in a corporation must act now as though his action would control the mass. A material man who raises prices for undue profit; a labor leader who blackmails a higher wage out of a driven contractor; an engineer who advises or starts an unnecessary piece of construction; each will be responsible for the break that will surely follow their combined performances. For each to consider himself the controller of the situation will hold the curve of progress within normal bounds and by so doing each will help to prove our English prophet without honor even in a country not his own.

Record Height Multiple-Arch Dam Under Way in Italy

Tirso Dam for Power and Irrigation on Island of Sardinia Is 200 Ft. High and Has Seventeen Reinforced-Concrete Arches on Stone Masonry Buttresses

By I. Gutmann
With the Hydraulic Division of the Electric Bond & Share Co.,
New York City

THERE is now nearing completion in western Sardinia, Italy, a multiple-arch dam 200 ft. high—the record for that type of dam—which is of novel design in that the reinforced-concrete arches of the deck are supported on cut-stone masonry buttresses. It is known locally as the Santa Chiara di Ula dam, but it is across the Tirso River, and has also been called the Tirso Dam. The dam is the main structure of a power and irrigation project, generating some 30,000 hp. peak capacity and irrigating about 75,000 acres.



DOWNSTREAM FACE OF WORLD'S HIGHEST MULTIPLE-ARCH DAM UNDER CONSTRUCTION
The Tirso dam in Sardinia is 200 ft. high and has seventeen 49.2-ft. span reinforced-concrete arches on stone masonry buttresses.

The Tirso is the principal river on the island. Its drainage area above the dam site is about 800 square miles. The region of the watershed is semi-arid, not unlike the coastal ranges of California in its character. Naturally, the discharge of the river varies greatly, viz., from nearly zero, in the middle of summer, to 35,000 sec.-ft. after heavy rainstorms, in winter. According to an estimate based on stream flow studies, the average available discharge of the river is about 700 cu.ft. per second.

The reservoir formed by this dam will have a surface area of some 8.5 square miles and will store some 330,000 acre-ft. of water; in other words it has about 85 per cent of the capacity of the Ashokan reservoir, but not quite one-fourth of the Roosevelt reservoir. The reservoir will irrigate ultimately some 75,000 acres of land. Of these some 12,000 acres are covered with malarial swamps, which are being drained while the dam is built.

The power station will be of 10,000 hp. normal capacity and 30,000 hp. peak capacity. It is worth while noting here that the power station is being built within the body of the dam, in its five central panels. From this station energy will be supplied to all points on the island, particularly to the zinc and lead mines.

The reservoir will also prevent the floods which used to ravage the lowlands of the Tirso basin.

Description of the Dam—According to the designers the multiple-arch type was adopted not so much on account of its being more economical than a gravity dam (the saving in this case is said to amount to 20,000,000 lire) as on account of its being deemed safer as to

temperature cracks, a consideration especially important for dams in arid and semi-arid regions where the lowest temperatures occur at the time of highest water.

The dam will be 200 ft. high (61 m.), counting that height as the distance between the continuous crown of the arches (110.0 m.) and the average foundation (49.0 m.). High reservoir level is El. 109.0 m. and low tailwater is El. 52.6 m. The foundations of some of the buttresses are, however, many meters below the 49-m. level. The foundation rock is trachyte. Tests have shown that its crushing strength is about 11,800 lb. per square inch.

There will be altogether seventeen arches of 15-m. (49.2-ft.) span. The buttresses are trapezoidal in shape. Their upstream slope is 57 deg. to the horizontal and the downstream slope is 70 deg. 40 min. to the horizontal. The top of the buttresses is 5 m. (16.4 ft.) long. Their length increases downward in accordance with the formula: Length = (distance from top) + 5 meters. At El. 49 m. (base of dam) the buttresses are 66 m. (216.5 ft.) long. At El. 61 m. the buttresses are prolonged to carry on arches a road to serve the power station. The thickness of the buttresses varies parabolically from 2.50 m. (8.2 ft.), at the top, to 7 m. (23 ft.) at El. 52 m. Below this level a uniform thickness of 10 m. (32.8 ft.) is maintained. The buttresses are built of rough pointed trachyte stone and are faced with ashlar. The courses are horizontal, except within the zone of the most intense pressures, i.e., within the triangle at the downstream toe, where the courses are inclined normally to the resultant pressures. To every three square meters of buttress wall there is a steel tie-rod, hooked at the ends, which binds the masonry laterally. The ends of the tie-rods will support the brackets of a movable inspection foot-bridge.

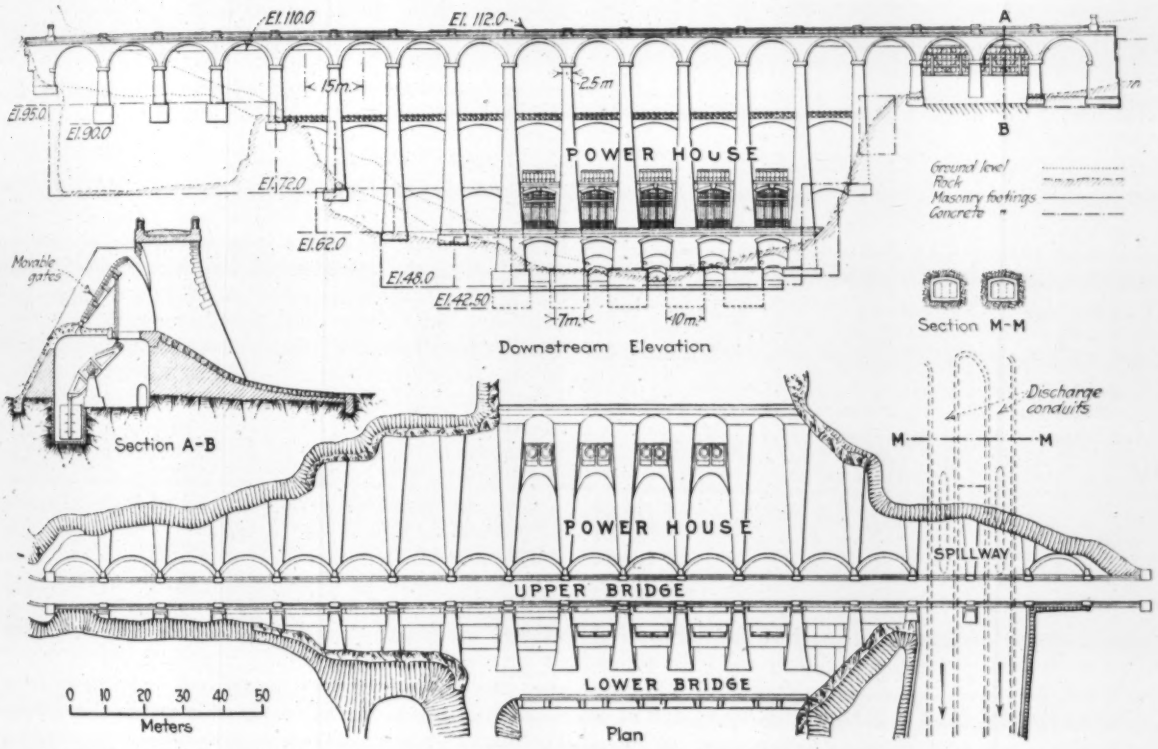
The maximum compression in the buttresses has been calculated not to exceed 191 lb. per square inch.

Pressure Measurement—It is proposed to measure the actual pressures within the masonry of the buttresses by means of carbon sticks fitted into stone blocks embedded in various levels of the buttresses. It is well known that the electrical resistance of carbon varies quite regularly with mechanical pressure exerted upon it. Holes will be drilled through the stone blocks, carbon sticks a trifle smaller in diameter will nearly fill the holes and the remaining free space will be paraffined. The sticks will be connected with an electric bridge and calibrated for pressure. Later these blocks and carbons, provided with insulated wires, will be embedded in the masonry and their resistance observed. The pressures will be calculated from the observed resistances.

The buttresses are strut-tied by means of four series of arch bridges. Besides the bridge carrying the power station roadway, mentioned before, there is also a series of four bridges, 3 m. wide, at El. 70 m.; and a series of three bridges, 2.50 m. wide, at El. 90 m. The buttresses are further braced at the top where they are crowned with a massive series of semi-circular vaults, 12.50 m. in diameter, carrying the provincial highway. The highway is protected with a solid parapet of gray-azure granite. The gray azure on top of the reddish trachyte will make a very pleasing color scheme.

Communication between the bridges strut-tying the buttresses is made possible by footwalks clinging to the buttress-walls and by means of openings made in the buttresses. There is only one opening to a buttress for each series of bridges.

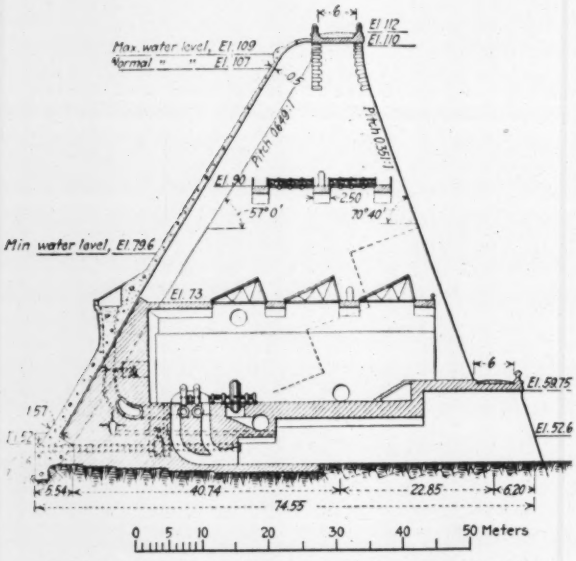
Deck Design—Upon the stepped upstream slopes of the buttresses rest the inclined reinforced-concrete



PLAN AND DOWNSTREAM ELEVATION OF THE 200-FT. MULTIPLE-ARCH TIRSO DAM

arches forming the face of the dam. The arched decks rise from a concrete escarpment built along the floor of the valley and penetrating the rock to a depth of some two meters. The arch rings, which are 15 m. in span, have been designed on the principle: rise equals one-third of span. This implies a constant angle of 133½ deg. The arch rings vary in thickness from 50 cm. (19.7 in.) at the top of the dam to 1.67 m. (5 ft. 6 in.) at the bottom of the central panels.

Within the uppermost 10 m., the arch rings are reinforced both at the extrados and at the intrados, carrying 8.12 kg. of steel per square meter; below this section only the extrados are reinforced with 3.64 kg. of



SECTION THROUGH DAM SHOWING POWER HOUSE AND BUTTRESS

steel per square meter. The reinforcement consists of longitudinal double bars 10 mm. in diameter, spaced 20 cm. apart; transverse bars towards the extrados, 4 mm. diameter, 25 cm. apart; and expanded metal 1.10 kg. per square meter.

The upstream surface of the arched deck is covered with asphalt below the penstock inlets and with gunite and waterproofing mixtures above that level.

The arch spandrels are partly filled by means of a heavy concrete slab reinforced as the arch and anchored in the buttress with steel rods. The top of the arched decks is provided with a heavy cope to shed the water off the arches.

The decks are true arches only for a height of 37 m. (121.4 ft.) from El. 73 m. to El. 110 m. Below El. 73 m. the arches have a permanent centering of masonry and back of it a heavy mass of stonework, in which the power station is housed. This great mass of masonry has been provided in order to dampen the vibrations produced by the power station machinery, also in order to compensate for the penstock holes in the arches and in the buttresses. Vertical drains run along the upstream face of this mass of stonework, intercepting seepage through the decks and discharging it into a main drain running along the base of the dam. About El. 63 m. another egg-shaped main drain, which is also an inspection gallery, runs through the center of the masonry mass. Blind adits radiate from this gallery upwards as well as laterally. These adits are numbered in order to facilitate reporting seepage conditions within the dam. Water from these adits and gallery is discharged into the tailrace of the turbines by means of a pipe 60 cm. (nearly 2 ft.) in diameter.

Power Station—The power station occupies the five central panels of the dam. Four panels house the turbines and motors, while the fifth holds the transformers and other appurtenances. There are four pairs of reinforced-concrete penstocks corresponding to four pairs of turbines, one pair to a panel. A pair of penstocks originating in one panel feed a pair of turbines located in an adjacent panel, east of the first, the penstocks going through the buttress separating the two panels. The penstocks were skewed in this fashion in order to avoid sharp curvature in them. The penstocks are sufficiently reinforced to withstand full maximum pressure on their outside, at a state of vacuum inside of them. They are protected with strong grizzlies and have a double control consisting of a plug in the grizzly chamber and a sluice gate located just back of the arched deck. There is in addition also the gate control of the turbines.

The power station is equipped with: two double horizontal turbines of 6,000 hp., total 24,000 hp.; two double horizontal turbines of 9,000 hp., total 36,000 hp.; and one auxiliary turbine of 60 hp.

Four three-phase alternating-current dynamos of 5,000 v. are coupled to the turbines. The current will be transformed from 5,000 v. to 75,000 v. The transformers are housed in a separate panel which is divided into seven floors and is provided with an elevator running in a shaft 40 m. high. Communication between the five panels is effected by means of openings, 2.50 m. in diameter, made in the separating buttresses. Four traveling cranes may be run through these passages.

The power station will be roofed with trussed sheds and its walls will be faced with majolica and polished stucco. Its front will consist largely of huge windows, 8 by 11 m. (26.25x36 ft.) each.

The floor of the power station is at El. 58.1 m. The axes of the turbines are at El. 59 m., the normal level of the tailrace will be at El. 52.60 m., giving a suction of 6.40 m. (21 ft.) in the draft tube. At very high water the level of the tailrace may reach El. 59.75, and then the power house will be flooded. The draft tubes discharge into a channel 5 m. wide which also carries the discharge from the galleries draining the dam as well as the discharge from two valve-controlled scouring pipes, 0.95 m. (3 ft.) in diameter, laid at El. 52 m.

Reservoir Outlets—The reservoir has no open crest overflow spillway. High floods are to be taken care of by gate-controlled outlets, near the eastern abutment of the dam, of a total capacity of 800 cu.m. per sec. (28,250 sec.-ft.). The gates are of a cylindrical type. They can be worked by man power and can also be adjusted to become automatic in action for any desirable level within a certain range.

There are also two tunnel outlets, near the eastern abutment, 37 m. (121.4 ft.) below the top of the dam. These outlets are controlled by means of four sluice gates and will discharge 800 cu.m. per sec. (28,250 sec.-ft.) when operated at full head.

With simultaneous operation of all the outlet means, including the penstocks and the scouring pipes, a discharge of some 2,000 cu.m. per sec. or 70,000 sec.-ft.

can be taken care of, which is about 87 sec.-ft. runoff per square mile of watershed. The outlet provisions can by no means be considered excessive. They are likely to be inadequate inasmuch as there is no simple overflow spillway and as the operation of all the outlets depends upon human factors and fairly intricate machinery, which may fail at the critical moment. Recent Californian practice is to provide open overflow spillway capacity at the rate of 200 sec.-ft., or more, per square mile of watershed.

Foundations—In the bottom of the valley, under a covering of very hard rock, there was discovered a thin layer of sand overlying a dark tufaceous rock, readily soluble in water. The porous tufa was excavated and masonry was substituted in its stead. A deep pocket of similar tufa was found also under three buttress-sites at the western abutment. The footings of these buttresses were enlarged and a concrete diaphragm was built down to El. 72 m. which is well within firm rock. A concrete diaphragm of varying depth is built all along the dam profile.

Construction Details—The construction of the dam was commenced in 1917 during the worst period of the war, about the time of the Caporetto disaster. The island was blockaded and all the able-bodied men were at the front. Labor, necessary supplies and transportation means were hardly available.

The dam site is situated in a very unhealthy, malarial region. In spite of the fact that all the men were taking quinine regularly and that some drainage work was promptly executed, many lives were lost and the efficiency of the men was greatly reduced. During the war the force consisted of 400 Austrian war prisoners. After the armistice, with the return of the Sardinians from the front, things picked up, going at a very satisfactory rate ever since. By now about two thirds of the work has been done.

The stone and sand come from nearby sources. The mortar used is made of equal volumes of sand and crushed basalt and about 507 lb. of cement to the cubic yard. At the age of 28 days it averages 1,900 lb. per sq.in. in compression, and 220 lb. per sq.in. in tension, at 180 days 3,980 lb. per sq.in. in compression and 497 in tension.

The buttresses and arches have been built at the same time. No great floods have occurred and the sluices under the center of the dam have been adequate so far.

Power is produced in a fuel electric plant of 411 hp. maximum capacity. Power costs about 40,000 lire per month. The construction plant consists of the following main items: Aerial cableway, 220 m. (722 ft.) long, 70 mm. (2¾ in.) cable diameter, 7 tons capacity; towers, one stationary and one oscillating, 22 m. (72 ft.) high; traveler, 8-m. (26.24-ft.) span, 4 tons capacity; two electric cranes with 29-m. (95-ft.) struts, of 20-m. (66-ft.) working radius, 2 tons capacity; two steam cranes, three four-ton derricks, two winches on towers 20 m. (66 ft.) high, eight motor winches, etc. four air compressors, one cement gun, one grout injector, two half-yard concrete mixers; rock-crushing plant; power drilling rig capable of drilling to a depth of 400 m. (1,312 ft.); one hand-drilling rig; seven large pumps, one working against a head of 680 ft. and making 4,000 r.p.m., the belt running 124 miles an hour; two steam trucks; five 35-hp. tractors with four five-ton trailers to each; a thirty-ton trolley car, etc.

The laborers' camp can accommodate 1,300 men. It is provided with a flour mill and bakery. There is also a steam laundry equipped with a drying chamber, electric ironing machine, etc. There is a large public bath with showers and dressing rooms. There is a hospital with twenty beds, an operating room fully equipped for major operations, a bacteriological laboratory, X-ray cabinet, etc.

The concession for the Tirso development is held by an Italian company, Imprese Idrauliche ed Elettriche di Tirso. The dam was designed by Luigi Kambo, who also superintended its construction during the early stages. The project has been described in the *Annali del Consiglio delle Acque Pubbliche*, published by the Ministry of Public Works of Italy.

Precast Concrete Slabs Replace Wood-Block Bridge Floor

A PLANK and wood-block floor has been replaced by a floor of precast concrete slabs on the easterly half of the Connecticut River bridge connecting Holyoke and South Hadley, Mass. The change was made to reduce maintenance costs, which were high. Eight years' wear of the old floor, consisting of creosoted wood block on 4-in. chestnut planks, produced so uneven a surface that a new floor was necessary, and it was decided to pave with concrete. As traffic had to be maintained, precast slab construction was chosen.

The slabs were cast in a yard near the bridge. To assure a good fit of the slabs the floor of the bridge, which is slightly skewed, was laid out in the yard, and steel members were set in the same position as the stringers and floorbeams and to the proper heights, determined by accurate levels. The bottom of the mold between these members was formed of sand, except that wooden forms were used to shape arched recesses in the bottom of the slabs. The slabs are about 8 x 20 ft. in size, 13 in. thick at the ends and 6 in. thick at the arched crown, and weigh 8½ tons each. They fit excellently when placed in position. The car-track strip, on one side of the bridge floor, served to carry traffic around the working point on the floor.

According to a brief description of the work by H. W. Woodill, in the Portland Cement Association's *Concrete Highway Magazine* of February, the trusses of the bridge, 160 ft. in span and of double-intersection web type, were strong enough to carry the added weight of the concrete floor, but the stringers and floorbeams were not adequate. The floor system was therefore reinforced by putting in additional floorbeams, midway between the old floorbeams, spaced 16 ft., and suspending the new floorbeams by hangers from the intersections of the web members.

The concrete slabs were molded early in the fall of 1921 and placed on the bridge last summer.

Minutes, Not Feet

In "Four Problems in Surveying," an article by L. F. Hammond in the April 26 issue of *Engineering News-Record*, the fourth line from the end of the article read: "If 'a' is under 10 ft., . . ." whereas it should have read: "If 'a' is under 10 min., . . ."

New Water Purification Plant at Norfolk, Virginia

Aerator Weirs—False-Bottom Underdrains, Coagulant Basin Superimposed on Clear Well—Flume Type of Wash-Water Tank

SEVEN-DROP weir aerators, concrete false-bottom underdrains, a flat concrete wash-water tank over the filter operating gallery and a clear-water basin under the coagulation basin are features in the new filtration plant at Norfolk, Va., put into operation late in 1922. The plant is one portion of the improvements and extensions that have been under way since 1920 when a providential rain saved the city from a water famine. So low had the supply dropped that steps had been taken to pump salt water into the mains for fire protection and sanitation and to supply drinking water to the 120,000 inhabitants from tank cars, motor sprinklers and wagons. The new system comprises the

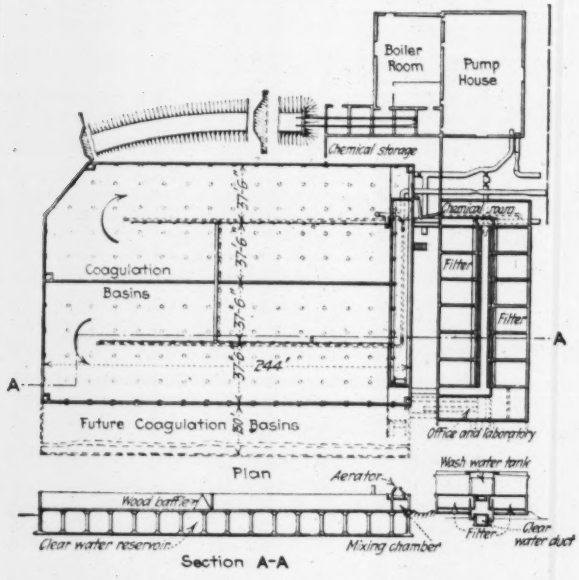


FIG. 1—GENERAL PLAN, NORFOLK FILTRATION PLANT

Lake Prince 4-billion-gallon storage dam, 20 miles west of the city, connected to the distribution system by 18½ miles of 30 and 36-in. cast-iron, wood-stave and concrete pipe. A pumping station below the dam, housing three 15-m.g.d. motor-driven centrifugal pumps forces water through these mains to the filtration plant located a half mile from the Elizabeth River crossing in the western part of the city; designed for a normal capacity of 24 m.g.d. only one-half has been installed. The following notes on the plant are taken from a paper by Walter H. Taylor, III, city engineer, presented recently before a convention of engineering societies at Richmond:

On reaching the filtration plant (see plan, Fig. 1), the raw water is dosed from alum tanks located on the ground floor of the chemical house in the western part of the filter building. For convenient charging from the second floor, the chemicals in carload lots are received on the second floor and stored on both floors. Orifice tanks control the rate of dosage and hydraulic ejectors force the solution into the main. This arrangement made unnecessary an elevated "head house."

Mixer—A few feet beyond the point where the alum solution enters the main, the water passes into a baffled mixing chamber, where the velocity is 0.8 ft. per second and the detention period seven minutes when operating at the rate of 12 m.g.d.

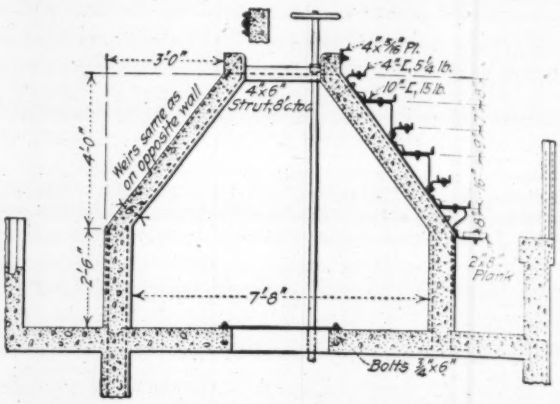


FIG. 2—CROSS-SECTION OF WEIR AERATORS

Aeration—Immediately above the mixing chamber is the aerator (Figs. 2 and 4). The water falls successively over four weirs each side, and between weirs it is broken into a spray by splash plates. This arrangement of aeration of water after passage through the mixing chamber was adopted not only to remove tastes and odors but also for the double purpose of giving a final mixing of the water and alum solution and to release carbon dioxide formed by the chemical reactions.

Coagulant Basins—From the aerator the water passes to the two coagulating basins, designed for a detention period of five hours. Each basin, midway of the first passage, has a baffle or skimmer, made of wood to permit of change of location if desired. In front of this baffle is a row of mud valves connected to the cast-iron sewer. By an occasional opening of these valves it is believed that large quantities of the precipitated matter, mostly of a vegetable nature, will be removed, and thereby greatly lengthen the period between dewaterings of the basins for thorough cleansing. Both basins are connected to the influent duct to the filters. In leaving the basins the water must pass over a submerged weir wall, which is designed as a further precaution against passage of sediment to the filters.

Clear Water Storage—Beneath the coagulating basins, and occupying the same area, is the clear-water reservoir

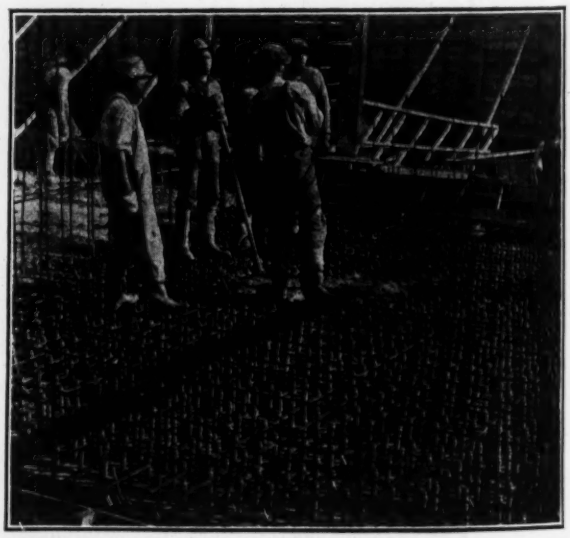


FIG. 3—TOP OF FALSE BOTTOM OF UNDERDRAIN SYSTEM
Strainer system consists of ¾-in. pipe, 6 in. c. to c., extending through top floor of false bottom; ¾- to ½-in. reducers carry umbrella-type strainers.

of 3,500,000-gal. capacity. The floor of the coagulating basins forms the roof of the clear-water reservoir and is a 10-in. flat slab with 4-in. drop panel supported on 20-in. columns spaced 15½ ft. each way. The columns rest on the floor of the reservoir, which is of similar design, a flat slab, but inverted, to spread the load evenly over the soft underlying sand. The bottom slab is extended outward, forming footings for the side walls. As the excavation was 11½ ft. deep the added pressure on the subsoil amounts to less than 1,000-lb. per square foot.

The concrete work of the reservoir and basin was carried forward in a manner to produce a minimum number of construction joints. Slab sections 31 ft. wide by 150 ft. long were poured in one continuous operation. Each construction joint had a 6-in. copper strip carefully imbedded 3 in. in the concrete each side of the joint. Two per cent of fine clay was added to the cement for making the concrete for the floor of the coagulating basin. No "chuting" of concrete was allowed, each batch of concrete being hauled in cars from the mixer to its location in the slab. No leakage has occurred through the slab from the 10 ft. of water standing in the coagulating basin.

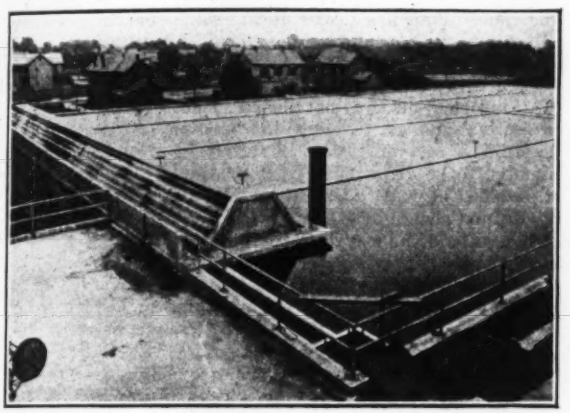


FIG. 4—AERATOR AT END OF COAGULATING BASIN
Two round-the-end baffled basins of 4-hour detention period are preceded by 7-fall weir aerator to remove tastes and odors.

The manner of superimposing the coagulating basins upon the clear-water reservoir resulted in great economy of funds and saving in land. The unusual purity of the raw water in this instance made it a safe procedure.

Filters—The twelve filter tanks have a normal capacity of 1 m.g.d. each. Instead of the usual system of manifolds and laterals of pipe, these filters have a "false bottom" 2 ft. deep formed by an 8-in. flat slab of concrete supported by the side walls and six short columns. Set vertically in this slab on 6-in. centers are ¾-in. galvanized pipes (Fig. 3) with ¾-in. brass reducers threaded to the upper ends. These reducers are placed flush with the upper surface of the slab and into them are screwed, Fig. 3 shows, the umbrella-type strainers. Sixteen inches of graded gravel and 30 in. of sand complete the filter beds.

Wash-Water Tank—Wash water is supplied either from a motor-driven centrifugal pump, controlled from the operating floor, or from a wash-water tank. This concrete tank is located under the roof of the building above the operating floor and is 14 x 101 ft., by 3 ft. deep. With this arrangement a uniform head is obtained for the washing of the filters and the unsightliness of an elevated structure eliminated. The tank was poured as a monolith and has been full of water for more than six months without the slightest evidence of leakage on the operating floor.

Col. Dabney H. Maury of Chicago has been acting in a consultant capacity on this work since April, 1920. The project has been under consideration by the department since 1912, under the writer. Norman Z. Ball was assistant engineer of design, and also had charge of the erection of the filtration plant. The Stanford & Brooks Co., of Baltimore and Norfolk, were the general contractors.

Los Angeles Engineers Approve Concrete Sewer Pipe in Sea Water

A REPORT of the Board of Public Works of Los Angeles summarizes the information gathered on a trip it made for the purpose of ascertaining from practical engineers their ideas on the value of reinforced-concrete sewer pipe when used in sea water. The reason for the trip was the desire, on the part of the board and the city council, to save approximately $250,000 on the cost of the permanent outfall sewer at Hyperion by substituting 7-ft. precast reinforced-concrete pipe for cast-iron pipe. The places visited on the trip included several cities on the Pacific coast and the Mare Island Navy Yard. At Oakland, Calif., they inspected 1,200 ft. of 36-in. reinforced-concrete sewer pipe, laid in 1907, which is entirely submerged at high tide; and 750 ft. of 5½-ft. reinforced-concrete pipe, laid in 1908, which is two-thirds submerged in salt water. Both pipes were found to be in as good condition as when laid fifteen years ago. W. W. Harmon, city engineer, stated that he considers concrete pipe as durable as cast-iron.

At Alameda, Calif., George Sperbeck, the assistant city engineer, showed the board their concrete sewers and expressed an opinion similar to that of Mr. Harmon.

At San Francisco the chief assistant engineer, Mr. Healy, reported that they had lined a 7 x 9-ft. tunnel with concrete, and that they had also laid reinforced-concrete sewers ranging in diameter from 6 ft. to 11 ft. in which a 1:2:4 mix had been used; that these sewers were subject to ebb and flow tide and were in first-class condition.

Mr. Earl, the supervising engineer of the Public Works Department of the Mare Island Navy Yard, stated that the navy had had so much success with concrete exposed to sea water that it has approved plans for extensive works at the navy yard in which concrete will be used. Mr. Earl stated further that in his experience he had never found any deterioration in concrete when properly made and if submerged at all times. In his opinion 1½ in. of concrete over the reinforcing was sufficient for submerged pipe. The government is specifying in some of its work that wax tailings be used to spray pipe that is to be only partly submerged. It is at present constructing a cooling system at the Mare Island power plant in which sea water will be used. The pipes here will be of precast reinforced concrete.

In view of the foregoing evidence the board recommended that precast reinforced-concrete pipe, of a minimum thickness of 9 in., be used for the mile ocean outlet at Hyperion.

Economy in Engineering

"To accomplish a given result for the least cost is the aim and purpose of engineering. Our architectural friends may find it hard to reconcile this definition with their profession; but I understand that they concede that that which is structurally correct, symmetrically proportioned and harmoniously colored must be good in architecture, and that needless embellishment injures, rather than improves, an architectural design and is therefore WASTE. WASTE the engineer must shun as he would a dread disease. Waste is a disease of our social order. Extravagance in any form of engineering or architecture comes back upon the ultimate consumer."
—Walter H. Wheeler, in a recent presidential address to the Engineers' Club of Minneapolis.

Operating Local Gravel Pits for Concrete Road Work

Locating and Testing Deposits—Planning the Pit Equipment—Installing Washers—Analyzing Job Costs

By H. J. Kuelling
Construction Engineer, Wisconsin Highway Commission

Abstract of paper read before the annual meeting of the American Road Builders' Association.

During 1922 in Wisconsin there were constructed 355 miles of concrete road. Of this mileage there were 187 miles on which the fine aggregates were shipped on a railway; 84 miles on which they were trucked or otherwise hauled directly from commercial plants; and 84 miles on which they were produced in local operations. In percentages these ran 52.8 per cent shipped; 23.6 per cent trucked from commercial plants, and 23.6 per cent from local production. In respect to coarse aggregate the corresponding figures were: 153 miles, 119 miles and 83 miles and the percentages were 43.1 per cent; 33.5 per cent and 23.4 per cent. On a basis of two parts coarse to one part fine aggregate, 54 per cent of the tonnage on these 355 miles of paving never saw a railway. This means cheaper concrete roads; a saving in freight; easing up on the burden of the railways; a saving in bond cost, and an easing up for the contractor in the all-important matter of financing his job.

Location Surveys—The location of gravel deposits is the duty of a geologist; all material parties are in charge of a geologist, just as they would be if deposits of lead or iron were being sought. His knowledge of geology shows him where to seek the best supplies. The duty of the engineer, who accompanies the geologist in locating, is to study the deposit from the physical viewpoint of whether or not it can be successfully operated.

Each party is equipped with a Ford ambulance of the type used in the World War. It is also fully equipped with shovels, picks, scales, containers, screens, glacial and soil maps, and any other tools necessary efficiently to conduct the work. Some of the parties carry along small cooking outfits while practically all of them sleep in their cars at night. They are paid salaries and have to maintain themselves but they turn in an expense account for the car. Each party is given a number of proposed projects to cover.

The methods vary with the kind of material being sought. Those parties whose task it is to locate concrete aggregates have to spend more time and take more care in the results than do those parties who are locating surfacing materials.

A party locating aggregate must first try to locate a satisfactory deposit as near as possible to the center of the project. If this is impossible they must widen out in their search, always keeping in mind the disadvantages of long hauls and poor setups. They must also locate in each case the nearest water supply. They usually do some test-pitting, especially on undeveloped deposits, to determine the amount of stripping and otherwise prove their conclusions. In general, a field test is made of the material in the nature of a silt, colorimetric and screen test. Their notes are kept on loose-leaf forms provided by the Highway Commission. The deposits are spotted by section, town and range, and the owners' names are obtained wherever possible. Each deposit is given a location number, these numbers starting at one and running upward consecutively in each county.

Such surveys cost the state in the neighborhood of $40 or $50 per mile of project. After the surveys are made and the field information properly analyzed it is the duty of the materials department and the district office to see that the most promising locations are properly test-pitted.

Testing the Deposits.—The test pitting is exceedingly important. It must be done extensively and thoroughly. If several miles of concrete road are to be built out of a proposed pit, it is necessary very thoroughly to test-pit the site, especially if it is an undeveloped deposit. Enough holes should be dug to determine the extent of the deposit and they should be dug deep enough to determine the working face. Holes 30 ft. and over in depth have been dug by using box sheeting of 2 in. boards 4 ft. long. It is an easy matter to construct a windlass operated by hand, and with a hole 4 ft. square a fairly large bucket can be attached for raising the material. The samples should be taken at the time of digging. The requirement is a sample of 500 lb. pit-run material. The samples should be taken from several different holes. Probably the best method of handling is to sack the material in cement sacks. Tags are filled out and one is placed inside the sack and one attached, after which the sacks are sent express or freight collect to the laboratory at Madison. The man supervising the work also fills out an aggregate sheet furnished by the Commission describing the deposit, which sheet he sends direct to the materials department. Here a duplicate is made and sent to the laboratory and the original is kept in the files.

From these samples tests are made, both on the fine aggregate and the coarse. Sand briquettes are made for breakage at three, seven and ten days. Coarse aggregate is tested in specimens 18 in. long, 8 in. wide and 4.3 in. thick. Specimens of standard material are made at the same time. Both are tested at the same time in a rattler and later in tension and compression. By always running these tests with a standard, we not only can compare the material with the standard, but with any other.

The information thus obtained is placed in the hands of prospective bidders through the medium of the district offices. The cost of testing material from one deposit is estimated to be about $35. If a prospective bidder is still not satisfied he may make an investigation of the material himself, and should by all means make a most careful investigation of all the physical features surrounding its use, such as water supply, topography, soil and roads.

Of course no proposed gravel pit can be guaranteed to be absolutely safe. Even with the best kind of test-pitting a few deposits when opened up will disclose objectionable features which were not apparent before. These may be a pit running to sand, too many oversize boulders, and a pit containing heavy seams of clay. These failures, however, are few, and often where there has been a failure some bit of negligence or ignorance was responsible for it.

All this detail of locating and testing has been given thoroughly to impress the fact that local production requires considerable gray matter before one should think of the equipment and operation.

Pit Equipment—The plant must be stationary; there is no such thing as an efficient portable plant for producing concrete aggregate. Another requirement is adequate bin capacity, for if there be a breakdown in the pit-operating machinery and the bins are filled, the trucks or other hauling equipment are still able to operate. Of course, the entire equipment must be efficient and efficiently operated. Too small a crusher or screens, not enough horse power, poor management, and a poor pump in case of washing, are some of the reasons for a plant not operating efficiently. The contractor in choosing his setup and machinery has quite a problem on his hands. He should look the proposed site over well and take all the factors into consideration. He must consider the distance he is to be from the project and also the method of hauling to and charging the mixer.

A well built and efficient gravel plant for producing aggregates should cost in the neighborhood of $10,000 to $12,000, including the items of erection. The difference is the difference in cost between a washing and a dry-screening plant, freight, erection, etc. A plant of this price has a bin capacity of about 200 cu.yd. which ought to be sufficient. Below is a table showing the approximate cost of a stationary gravel plant:

Crusher	$2,800	2—60 hp. motors	$2,200
Grizzly screen	50	Elevator	500
Blade feeder	300	Screens	400
Cables, sheaves, etc.	300	Lumber for bins, etc.	1,000
Hoist	1,000	Cost of erection	1,000
Drag line bucket	450		$10,000
Cost of washing equipment			$700

Another item, which is really an extra, is the measuring device. Where batch trucks, for instance, are to be used this is an absolute necessity. There have been attempts to construct home-made devices with moderate success. There are mechanical devices on the market which are quite successful. They are, however, expensive as an outfit costs about $500.

Plant Examples — Two plants of one contractor are identical and while not absolute models of perfection they are worthy of description. An arrow-shaped dragline bucket handling about a cubic yard at a time pulls the material up, where it is dumped through a trap onto the blade feeder. This feeder is in the form of an endless belt which has a number of blades fastened thereon. This turns slowly and constantly dumps the material onto the grizzly screen. Thus the material is fed gradually to the crusher while the dragline is making its return trip. The rejected gravel from the grizzly drops into a No. 4 gyratory crusher set at about 1½ in. Then the material is carried up to the screens in a bucket elevator about 50 ft. high and containing approximately 140 buckets. The screens are of the revolving type, 4 ft. in diameter and in sections. The first section is 6 ft. with ¼-in. round openings; the second is 4 ft. with ½-in. round openings, and the third is 6 ft. with elliptical openings ¾ in. x 1 in. For dry screening a screen of the last section type is probably the best. However, the last section of screen should have 2-in. round openings to take care of any oversize material. A chute could be built from the end of this screen back to the crusher. It has also been found very necessary at times to insert a section of ½-in. round screen to waste the pea gravel sizes when the gravel in the deposit runs fine. Two 60-hp. motors furnish the power for operating this plant. One takes care of the blade feeder, crusher, elevator and screens, and the other operates the double-drum hoist operating the dragline.

The bins for this plant are 11 ft. wide, 36 ft. long, and 14 ft. deep. They are set on a concrete foundation 38 ft. long with a base of 3 ft. and tapering up to 16 in. The horizontal timbers resting on this concrete foundation and supporting the uprights are 10 x 12 in. The uprights themselves are 10 x 10 in. and 12 x 12 in. Seven 10 x 12-in. timbers are used as braces for the uprights. There are also fourteen cross braces 6 x 8 in. in size, seven on each side. The floor joints are 2 x 12 in. spaced on 6-in. centers. There is also cross bracing on the side of 3 x 12-in. timbers, two being used together making six pairs on each side. The floor and sides of the bins are of 2 x 12-in. planks, the studding being the same size as the floor joists. They are double rodded, the long rods being 1¼ in. in diameter and the short ones 1¼ in. The bin supports or wales through which the rods are bolted are 6 in. x 12-in. timbers doubled. These hold the whole bin together and there are three tiers of them, the first 1 ft. above the sill, the second 4 ft. and the third 10 ft.

Washing Device—A large proportion of local pits contain enough dirty material to require washing. Washing also expedites the work of the screens, especially on damp days. A number of different types of washers are used. Probably the most common is the old tilting box. The valve control or discharge for the washed sand in this type is dependent upon the weight of the sand contained in the settling tank. There are a few mechanical objections to a washer such as this. First, the inertia of so great a weight makes the valve action slow, so that with uneven feeds the valve does not always close in time to prevent a "runaway." Secondly, a tank of this sort is operated by balanced weights which to operate quickly must be set so that the valve does not close tightly when the feed of sand ceases but while the water is still coming. Sometimes, unless the valve is closed by hand, an amount of water and clay gets into the clean sand already discharged.

There are also steel conical tanks on the market which are quite expensive, but more efficient as the discharge is controlled by volume rather than by weight.

A good many pit operators are using a washer of a different type. This is really a mechanical conveyor settling tank. It consists of a large rectangular wash box of wood, with a discharge for clay and dirty water at one end. The floor of this box slopes upward at the other end to the top. A number of blades are fastened to an endless chain which operates over sprocket gears at either end of the box. These blades dip down into the water, and by close contact with the slanting floor carry the washed sand to the top where it is dumped over into the bins. There is a space at either end of each blade, which permits excess water to return to the tank. These blades continually agitate the dirty water in the tank and keep the dirt in suspension until it is carried off over the spillway. Plenty of clean water must be poured into the tank continually, and it is well to have several sprinklers playing on material as it is pulled up to be dumped into the bins. These washers are sold in two sizes, 4 x 18 ft. and 3 x 18 ft. respectively, and are priced at about $500, exclusive of any wash box lumber. The former size has a capacity of 40 tons of sand per hour and the latter 35 tons.

Any of these washers, of course, is for sand only. It is sometimes and, in fact, always, just as necessary to cleanse the gravel. For this a water pipe with an end spray can be discharged into the screens. This will aid very materially in pushing the sand through the sand screen into the settling tank, and also for separating the sand from the stone, when it has a tendency to stick together in damp weather. It is also advantageous to have a section of closed screen containing angle irons bolted to the sides, which may be termed a scrubbing chamber. One of the principal requisites for a successful washing plant is plenty of clean water. Four-inch pipe should be used, if possible, and a pump powerful enough and an adequate water supply to produce 250 to 300 gal. a minute, is necessary.

Representative Job Costs—From one pit about 6.53 mlies were built. The total job was 7.29 miles in length or 77,176.4 sq.yd. of paving. The low bid on this was $1.07 per square yard exclusive of cement, as against the lowest price bid for commercial material of between $1.12 and $1.16. This is a difference of about 7c. per square yard or a total saving of $5,402.35 on the entire job. However, the facts that the pit was easily obtainable and afforded a good setup, that the hauls were good, and that several contractors were interested who wished to go into their own material production, all had a tendency toward producing one of the lowest bids per square yard in the whole state.

Another job consisted of about 8 miles of 18-ft. paving; the low bid was $1.19 per square yard and the lowest bid per square yard using commercial material was $1.49, or a saving of 30c. per square yard. This meant a saving of approximately $25,344 on this one job. This plant was equipped with a hoist and upright boiler, arrow scraper, one 60-hp. motor, a loader elevator, a bucket elevator, old style washing plant, screens and 160-cu.yd. capacity bins. Provision was made to shoot the rejected oversize stone back into the pit. From this plant approximately 25,400 cu.yd. of sand and gravel were hauled out on the road. This meant an average of 250 cu.yd. a day on the road and does not include an average of about 20 to 25 cu.yd. of material wasted each day. Material was hauled in trucks onto the road and stockpiled every thousand feet. From the stockpiles a fleet of Ford batch trucks carried the aggregate to the mixer.

Another road, 3.3 miles in length, was constructed, the low bid being $1.29 per square yard using local material. The lowest price bid per square yard using commercial material was $1.45, a saving of 16c. per square yard. This means a saving of $5,575.68 on the entire job. The material was trucked onto the roadbed, stockpiled and wheelbarrows used to charge the mixer. This was the second season that the contractor had operated this pit.

Another job of 4 miles was partly constructed, about 3½ miles being built. The bid per square yard using local material was $1.11, whereas the lowest bid per yard using commercial material was $1.35, or a saving of 24c. a square yard. This is a saving of $10,137.60 for the entire job. The material was hauled on the road, stockpiled, and wheelbarrows used to charge the mixer. They had about 6,000 cu.yd. of material stockpiled on the subgrade before the

actual paving work started. The equipment at the pit consisted of a bottomless dragline bucket, a plate feeder, a conveyor, a 9 x 15-in. jaw crusher, grizzly, a 36-ft. bucket elevator, a tilting box type washer, screens and bins, a 60-hp. tractor, a double drum hoist and upright boiler, a 10-20 tractor, and a centrifugal pump. The bin capacity was small, holding only 90 to 100 cu.yd. Provision was made to shoot the oversize stone back to the crusher. The 10-20 tractor furnished power for the pump which had a capacity of 450 gal. a minute, but only about 300 gal. a minute were actually used. The production of this plant was small as it averaged only about 150 cu.yd. of sand and stone to the road per day. The smallness of the crusher was greatly to blame for this as the 9 x 15-in. jaw crusher was only capable of a capacity of about 10 to 15 cu.yd. an hour. What they should have had in its place was a gyratory crusher No. 3 or 4-in. size. The bin capacity was small and the whole plant was not constructed in as stable a manner as possible, probably accounting for the numerous delays and breakdowns. It seems true also from various observations that a scraper of the arrow type will handle a larger amount of material than the bottomless bucket.

One county operated two local plants. One contractor built about 40,634 sq.yd. using material from one of the county pits. His price for this of $1.16 per square yard was based on material at $1 per cubic yard in trucks at the pit. This material had he shipped it in would have cost him $2.18 per cubic yard for gravel and $1.90 per cubic yard for sand in trucks at the destination. The comparative hauls were about the same.

The other county pit kept two pavers going and about 8 miles of road were built using thir material. It is rather difficult to get at the saving involved here as the contractor's bid did not include a material price, this being furnished him by the county. The county highway commissioner, however, believes that material was being produced in stockpiles for about 70c. a yard. Shipped-in sand and stone would have cost $2.03 and $2.20 per yard respectively unloaded in stockpiles or bins. As in the neighborhood of 26,000 cu.yd. of sand and stone were used in building the road it will be seen that considerable saving was involved (at least $30,000) by developing a local pit.

Decline in Typhoid and Other Death Rates

The typhoid fever death rate fell from 19.1 to 5.6 per 100,000 in the eleven years between 1912 and 1922 among the risks of the industrial department of the Metropolitan Life Insurance Co., of New York City. In the same period the decline for various other communicable diseases was: Diarrhea and enteritis (all ages) 27.6 to 10.7; tuberculosis (all forms) 212.9 to 113.4; communicable diseases of childhood, (measles, scarlet fever, whooping cough and diphtheria) 46.2 to 29.6; influenza and pneumonia, 116.2 to 94.7 and pneumonia alone 103.9 to 73.3, but with an influenza increase from 12.3 to 21.5. The 1918 rate for influenza and pneumonia combined was 542.2; for influenza alone, 272.4 and for pneumonia, 269.8. Accidents (all causes) fell from 73.8 to 57.7 and railroad accidents from 9.2 to 4.1; but automobile accidents rose from 3.0 to 13.5. Even diseases of the heart fell materially for the eleven years 143.8 to 126.0, but a sudden drop to 113.9 in 1919, the lowest year of the eleven, was followed by a rise to 117.0 in 1920, 117.4 in 1921 and, as stated, 126.0 in 1922. The general death rate fell from 12.01 per 1,000 in 1912 to 5.6 in 1922. The curve continued to fall in 1918, the influenza year, when the rate was 11.5, and dropped suddenly to 7.3 in 1919. Details for these and other causes of death are given in *Public Health Reports* for Feb. 23, where it is stated that the rates for 1922 are based on company records of approximately 14,000,000 risks.

Tar Impregnation for Concrete Drain Tile

CRUDE water gas tar is being investigated by the U. S. Bureau of Public Roads as a protection for concrete subject to alkali water attack. The methods of impregnating the concrete and the tests themselves are described in a recent paper by E. C. E. Lord, as follows:

The materials tested consisted chiefly of sections of well seasoned 6-in. concrete drain tile containing very little coarse aggregate, and ordinary 1:3 tension and compression strength specimens. The tile sections, after thorough drying in air, were immersed in thin liquid water gas tar at room temperature for a few minutes until all air had been expelled. Then they were removed from the bath and allowed to drain and dry out in air, or they were heated in the air bath at 110 deg. C. for four hours. In some cases two treatments of this kind were given in order to assure a complete penetration of the tar. It was found that the maximum amount of tar absorbed in this way was from 7 to 8 per cent after draining for 24 hours, and about 4½ per cent upon drying out in the air bath at 110 deg. C. Mortar specimens for tension and compression tests were treated in the same way, but were allowed to remain in the tar for six days before drying in the air bath.

To estimate the penetrating value of this tar, sand-mortar cylinders 4 x 2 in. were cured for seven days in damp air, dried in the laboratory for six days and then placed in glass-stoppered jars containing 25 cc. of tar. After one month it was found that the tar had penetrated uniformly upward to a height of from 2⅞ to 3¾ in. above its original level. A 3½-in. concrete slab (18 x 24 in.) cured in the same manner was given seven coats of tar at about 2-hour intervals. In all, this was at the rate of about ¼ gal. per square yard and the tar penetrated to a depth of ¼ in.

Exposure Tests—Analysis of disintegrated concrete drain tile after exposure to alkali soil waters has indicated in some cases a loss from the cement of about 30 per cent lime and the formation of gypsum (hydrous sulphate of lime) in large quantities. It was decided therefore to expose test specimens to a solution containing 1½ per cent sodium sulphate and 1½ per cent magnesium sulphate (which approximates an average maximum concentration of these salts in alkali soil waters) and to determine the amount of lime passing into solution as a measure of alkali attack. Sections of tile, both treated and untreated and weighing approximately 2,200 grams, were placed in porcelain-lined jars containing 10,000 cc. of the alkali solution and kept well covered. Determinations of lime were made from time to time and the solutions were renewed at frequent intervals.

The lime dissolved in the untreated samples did not increase progressively with the time exposed, but after reaching a maximum of about 4½ gr. in five weeks it appeared to decline, owing possibly to the formation of insoluble calcium sulpho-aluminate compounds. Comparing the total loss of lime in the untreated and treated samples for 38 weeks, the former had lost seven to nine times more lime than samples receiving a double tar treatment and half that amount for samples given only one treatment or two treatments followed by drying at 25 deg. C. The results indicate a 7- to 9-fold protection in the case of thoroughly impregnated material and about 4-fold protection when insufficient tar was absorbed or where the fixation of the tar residuum was incomplete before exposure to the alkali.

Tension and Compression Tests—These were carried out on mortar treated with water gas tar and on untreated material after remaining in 3 and 10 per cent alkali solutions and in tap water for 28 and 182 days. While the untreated samples failed completely after six months in a 3 per cent alkali solution, the treated specimens gave higher values for tension and about the same for compression as those stored in tap water for the same length of time. Treated samples stored in a 10 per cent alkali solution showed a loss in tension of about 50 lb. as compared with untreated samples after six months in tap water, but were 224 lb. stronger than untreated samples stored in the solution for the same length of time.

Bridging the Hudson River at Bear Mountain

Suspension Bridge of 1632-Ft. Span for Vehicular Traffic Being Built Above Peekskill—New Highway Connection

By Wilson Fitch Smith
Chief Engineer, Bear Mountain Hudson River Bridge Co., New York City

SINCE early days in the history of this country the Hudson River has been a natural barrier to the development of east and westbound traffic between New Jersey, Pennsylvania and New York on the western side and the New England States on the eastern side of the river, as well as within the Empire State itself. With the growth of the state's population there have been repeated efforts to bridge the river for vehicular traffic, but until the recent extraordinary increase in the use of motor vehicles, the ferries at various points

SKETCH OF PROPOSED BRIDGE AND APPROACHES

have afforded sufficiently satisfactory service as not to warrant the undertaking. With the advent of the automobile and the continued rapid increase in its use, first for pleasure, and more recently for commercial purposes, the ferries, despite their greatly increased facilities, have been unable to meet the duty, and the need for a highway bridge has become an urgent public necessity.

The bridging of the Hudson River at New York City has been studied for thirty years, but the width of the river, its depth, and the requirements for navigation as prescribed by the war department, are conditions that make it a stupendous project, which up to now has not gotten beyond the project stage. The Vehicular Tunnel now under construction by a joint commission of the States of New York and New Jersey will give some relief to the city, but it is probable that its capacity will be largely taken up by commercial traffic, and a highway bridge across the Hudson River at a point as close to the city of New York as is practical to build it, will afford a much needed service.

The nearest practical location to New York City is at the entrance to the Highlands, about three miles above Peekskill, and forty-five miles from Times Square, where the rocky shores of the river approach within 1,600 ft. of each other. This site was selected thirty-five years ago by the late Edward W. Serrell for a suspension railroad bridge, and some work was done at that time by the Hudson Suspension Bridge and New England Ry. Co. The site is ideal for a suspension bridge. On the east side of the river Anthony's Nose rises abruptly to an elevation of 900 ft., a solid boss of granitic gneiss, through which the New York Central R.R. tracks pass in a tunnel. On the west side the base of Bear Mountain, upon which can still be traced the remains of Fort Clinton, is of similar rock formation. Between these two rocky shores the river has a channel depth of 130 ft. Suitable rock foundations for the towers exist on both sides of the river at the shore line. Adequate anchorages on both sides can be had by tunneling into the solid rock on line with the cable back stays. The elevation of the surface on both sides is advantageous for the support of the approach spans.

These natural conditions, together with the fact that on the west side of the river lies Bear Mountain Park, a state reservation of over 33,000 acres, an increasingly popular playground for New York's multitudes, and that it will afford a direct avenue of approach to the scenic attractions of the Highlands, the cities on the west shore of the Hudson, the Catskill Mountains and the western part of the state, as well as a direct route for the largely increasing traffic between southern New England and the west side of the Hudson, determined the selection of this site for the first highway bridge to be built across the Hudson River south of Albany.

The Bear Mountain Hudson River Bridge Co. secured a charter from the legislature in March, 1922, and having obtained the necessary rights-of-way and permits, and completed its financing, the contract for construction was executed March 24, 1923.

Bridge Structure—The bridge will be a suspension bridge of 1,632-ft. span. The steel towers will be 355 ft. high above the foundations. Two steel wire cables 17 in. in diam. will each contain 7,252 wires, No. 6 gage. The cables will be 60 ft. c. to c. The stiffening trusses will be 30 ft. deep and 55 ft. c. to c., supported on transverse suspender beams carried by double suspender steel wire ropes of 2½-in. diam. At the east end the approach span will be 210 ft. long and will span the New York Central R.R. right-of-way. At the west end there will be a 210-ft. truss span over the West Shore R.R., a 100-ft. truss and two 50-ft. plate girder spans. The total length between abutments will be 2,238 ft. The bridge floor will be at the level of the top chords of the stiffening trusses and will be 48 ft. wide between railings, providing a 38-ft. roadway and two 5-ft. sidewalks. The floor will be a reinforced-concrete slab carried on 18-in. I-beam stringers with a sheet asphalt pavement. The suspended span will have a 15-ft. camber giving a clear height above the water at the center of 153 ft.

The weights of the various parts of the bridge are:

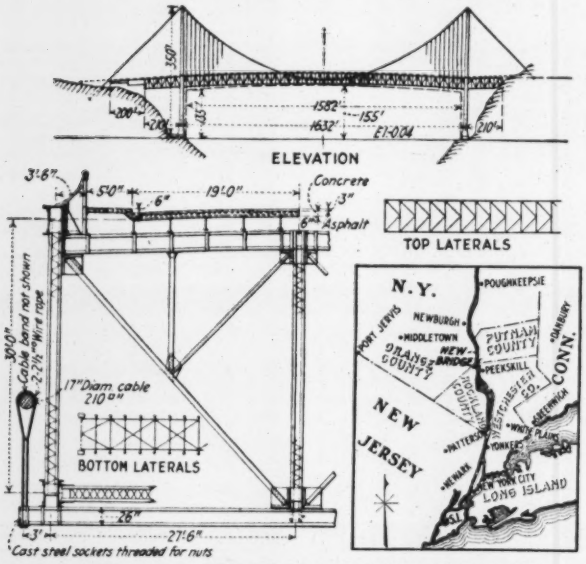
Towers	4,630 tons
Cables and suspenders	2,067 tons
Anchor bars and castings	906 tons
Stiffening trusses and floor	3,989 tons
Approach spans	970 tons
Total	12,562 tons

The cable wires and suspender ropes will be of 220,000 lb. ultimate strength. The stiffening trusses will be of silicon steel and the other portions of the bridge of carbon steel.

Approach Roads—The approach highway on the east side will leave Roa Hook road, about a mile from the Albany Post road at Annsville, just beyond the entrance to the State Camp, and by a 6.5 per cent grade will ascend the southerly slope of Anthony's Nose to

an elevation of about 200 ft. above the river, thence, generally following the contour but attaining a maximum elevation of 400 ft. will skirt the flank of Anthony's Nose to the bridge head, a total distance of about three miles. This will be a standard New York State concrete highway, with 18 ft. of paving. In places its construction will approach the boldness of the Storm King highway and it will afford many picturesque and spectacular views of the Highlands.

The west approach highway will be on the axis of



GENERAL DETAILS OF BEAR MOUNTAIN BRIDGE ACROSS THE HUDSON

the bridge and will connect with state route No. 3 at a point about 1,000 ft. from the bridge. This road will have a paved width of 38 ft. for its entire length. With the exception of two parcels on the east side, the entire length of the approach highways and the bridge piers will be on land either owned or controlled by the state.

Conservative estimates indicate a traffic of over 600,000 automotive vehicles a year in the first year of operation.

The contract time for construction is twenty-two months.

Personnel—The bridge was designed by Howard C. Baird of Hodge & Baird, who will act as consulting engineer on the bridge. The author is chief engineer on the work and William H. Burr and William A. Welch are consulting engineers for the company. The general contractors are the Terry & Tench Co., Inc. The cable wires and suspender ropes are being manufactured by John A. Roebling's Sons Co. of New York, and the fabricated steel by McClintic-Marshall Co.

Reaction Jetty Works Successfully

Navigation of the Fraser River in British Columbia as far as New Westminster by vessels drawing 30 ft. is now possible due to the effects of the single reaction jetty which has been built near the mouth of the river. (*Engineering News-Record*, Aug. 24, 1922, p. 318.) Construction on the jetty was begun in 1912 and has been carried on intermittently ever since, until now it is completed for about two-thirds of its length. When the construction of the jetty was begun the depth over the bar was only 16 ft.

Suggestions for An Engineering Employment Service

Plan Proposed for Nation-Wide Paid Service Under the Auspices of the National Engineering Societies

By Morris Llewellyn Cooke
Consulting Engineer, Philadelphia, Pa.

TINKERING with the system by which at present engineers out of work find jobs may easily reduce the unit cost of placements. Tinkering may even result in increasing the number of jobs found—especially in metropolitan districts. But no amount of tinkering will give us an employment system representative of the profession's capacity for organization, or meeting the legitimate expectations of those requiring the service, or fulfilling our obvious obligations to the nation and to society at large.

The new service must be of a character which will inspire inquiries from sources not now open. In only a negligible number of instances where vacancies occur in what may legitimately be called the engineering field are inquiries made of the existing agencies. I do not recall one employer who considered this *the* way to fill an engineering position. At best it is looked upon as a possible source of likely prospects for the more highly standardized jobs. It is equally true that applicants for positions approach existing agencies with no real confidence in the outcome. For jobs above a certain grade the "probability of hit" is very low.

The "load factor" of the present service is very unsatisfactory principally because we are seeking to cover a very broad field with an entirely inadequate plan. In consequence the record made—let us admit that it is a good one in its way—is based either (1) on occasional and largely accidental service rendered to a widespread national constituency, or (2) much more frequently on service to a comparatively limited number of members in the large cities—especially in New York City—seeking jobs of a rather unspecialized variety. There does not appear to be any way by which the "load factor" can be radically improved without a radical change in our conception of what constitutes an adequate employment agency for the engineering profession.

The Service Should Not be Free—Fortunately any service sponsored by the engineering profession does not need to be run for gain. In fact the demand will be that the service be rendered at cost—cost including the support of continuing an adequate research into all those phases of personnel work on which any effective placement and employment service for engineers must rest. *Such a service cannot be free.*

Placement fees must be charged. But these can be lower than those charged by agencies operated primarily for profit. They can be reduced of course after the initial capital outlay has been amortized and they can be made discriminative in favor of those who support the profession through engineering society membership.

Personnel management more and more works on the theory that for each job there is one best man. But to find him in the least possible time means job standardization and classification, the systematization of interviewing, the separation of the exceptional from the routine in placement work, symbolization to permit prompt—even telegraphic—exchange of data about supply and demand, telling advertising methods, etc.,

etc. It means the close integration of all factors in the engineering field, colleges, technical societies and employers both public and private.

Independent of National Societies—Any paid employment service for engineers to be successful should stand clear of the organization of all national and local societies. Some method can be evolved by which the profession can hold title in perpetuity and exert its authority at stated intervals, should the necessity therefor arise. But to be effective the new agency must not only be manned by the leaders of the profession but should be untrammeled by the frequent elections and other cumbersome paraphernalia of our largely accidental political system.

The governing boards of the five largest engineering societies might be given the power every fifth year to vote as to whether a change in the management in whole or in part was desirable. If the agency was running along smoothly and successfully there need be no interruption in the management. If a more direct expression of engineering opinion is desired referendums could be taken at regular intervals or at the request of a majority of the membership.

The new paid employment service for engineers can be developed and operated without any reference whatever to existing free agencies—national or local. Its success will not be conditional on making the placements now more or less successfully made by these existing free agencies. The new agency can wish all present free agencies Godspeed. In fact co-operation can be established at once between the two types of service. The ideas are by no means mutually exclusive. Free employment service is such an integral factor in most engineering organizations that one cannot look far enough ahead to predict its abandonment. As the paid service however begins to function the free service will naturally be retained only in those places where it can continue to demonstrate its usefulness. Both types of service can be simultaneously sponsored by the profession. It may easily develop that the more active the free service the better the paid service.

Organization and Operation—The directing organization of the proposed paid service might well be composed in part of the "best minds" within the profession and in part of outside individuals, each having some special contribution to make. An educator like Hopkins, president of Dartmouth College, who has had training in personnel work in large corporations; a lawyer like Owen Young, chairman of the General Electric Board; a psychologist like Walter Dill Scott, president of Northwestern University, and a banker like Dwight Morrow of the Morgan firm would each add effectiveness.

There is no reason why the organization should be of a standard type or even "frozen." There is room for experimentation and it would be well to let experience freely suggest the possible line of quick evolution. An annual meeting of the policy-forming Council, or at most semi-annual meetings would make it possible for busy and widely separated engineers like Rae, Hoover and Morgan to sit. Especially during the formative years it might be well to have an additional administrative board with monthly meetings and a membership recruited geographically so as to make attendance possible.

If for no other reason than to provoke discussion I submit an estimate of the earnings of such an agency. It is well within the actual figures to state that there are 100,000 engineers in the United States, and that on the average they change jobs once in five years. This means 20,000 new jobs secured every year. Further we can assume that an energetic and ably managed paid employment agency backed by the entire profession could in two years become responsible for finding 20 per cent of these jobs or say 4,000 a year. (This means 333 a month or 13 in a day.) Surely this is not an unwarranted expectation. Dividing the jobs secured in accordance with the salary ratings of over 300 engineer employees in the City of Philadelphia and using a 5 per cent fee for all salaries over $2,000 a year and a 2 per cent fee for all below that figure there would result a revenue of $8,400 for each 100 placements or $352,000 a year on the assumed 4,000 jobs. On any such volume of business the fees could soon be cut as estimates of operating expenses do not appear to require this income. The fees suggested are less than those charged by existing agencies for other occupations. As long as free agencies for engineers are maintained no member of any society would be under any compulsion of course, to use the paid service. There is usually, however, an embarrassing interim "between jobs" which probably averages longer the higher the pay. At $2,000 a year, reducing this time by one week would be about equivalent to paying a 2 per cent fee. Better service may easily pay for itself in more ways than one.

If careful engineering studies such as should be undertaken before the enterprise were launched confirm the foregoing estimates the financing becomes easy. A two year underwriting of $40,000—to be borrowed in whole or in part during the first year—could be paid back during the second so that the underwriters would possibly at no time be out of pocket. If it should be decided to arrange for this underwriting without in any way utilizing the credit of engineering societies it would be relatively easy to secure 80 individuals to underwrite $500 each, or say 40 for $500 each and the balance in larger amounts.

This great new departure in engineering technique—important alike to the individual engineer and to society—can be set going without putting the slightest financial burden on our at present overtaxed engineering organizations. If the boards of four or five of the larger national engineering societies should endorse in principle this plan for a paid employment service there would appear to be no serious obstacles standing in the way of its fairly prompt execution.

Progress on Vehicular Tunnel

Five compressed-air shields will soon be in operation on the vehicular tunnel, according to the New York State Bridge & Tunnel Commission Report for the year 1922. Already 600 ft. of tunnel have been constructed and the Canal St. shield is out under the Hudson River. The contracts for the construction were let March 28, 1922. In December of the previous year, the commission obtained from the Erie R.R. Co. the water-front rights on the New Jersey shore and in June 1922 received similar rights from the city of New York. During 1922 the commission acquired all the necessary land for the New York approaches. Contract No. 5, covering the construction of these approaches will be ready for advertisement about June 1, and contract No. 6 for the New Jersey approaches will be ready soon after.

Truck Overloads Threaten Life of City Pavements

Truck Loads of 15 to 25 Tons, Free to Travel Any Street in Most Large Cities, Are Breaking Down Pavements Not of Heavy Rigid Types

Editorial Review

PAVEMENT damage by excessive truck loads which at times or somewhat commonly travel the streets is arousing concern in most large American cities. Except on the main business thoroughfares few city streets have pavements designed with motor truck traffic in mind. Few cities exclude travel of any kind from any streets except certain park boulevards and drives restricted to pleasure traffic. In these respects the practice of the days of horse-drawn vehicles continues into the present period of mechanical propulsion with all that it permits in the way of large loads and high speeds. Traffic and the road on which it moves have grown out of co-ordination. These statements do not express any unfamiliar thought but it is useful to consider briefly what have been the actual results arising from the conditions stated.

A survey of about twenty large cities partly through questionnaires but more often through visits to these cities and consultation with the city officials of streets, is the basis of the information which will be presented. The consideration resolves itself into five phases: (1) Loads and their frequency, (2) Nature of damages, (3) Limitations of traffic, (4) Regulatory practices and (5) Remedial plans.

Loads and Their Frequency—Traffic tonnage counts over a considerable period of years have rarely been kept and then for certain main streets only. The statement generally offered by the average observer is that tonnage has multiplied several times. In Manhattan, New York City, on a certain section of Third Ave., counts made in 1911, 1915 and 1922 show the tonnages of traffic per foot width of street to have been respectively 72 tons, 167 tons and 220 tons. In brief, in ten years the traffic tonnage carried by the pavement had tripled. Other streets in New York or some streets in other cities have probably experienced a greater increase and it is certain that on many the increase has been smaller. The fact to be held to is that rash guesses of the increase in traffic tonnage have to be guarded against; on only a few streets originally heavily traveled, is the tonnage per foot width more than three times as great as it was ten years ago. This statement excludes streets that have suddenly become heavily traveled through a shift in industrial centers or by a rerouting of traffic due to some other cause.

Traffic tonnage increase is due both to the increase in the number of vehicles carrying load and to the increased weights of the loaded vehicles. It is the last cause, aggravated by increased speeds, that is considered to be largely responsible for pavement breakdowns. Here it needs to be remarked that it is pavement breakdowns, either the surface by crushing or shoving or surface and base by crushing or pressing down into the earth below, and not pavement wear, that constitutes the heavy-load trouble which most concerns street engineers. The increased traffic tonnage, except as it is represented by the excessively loaded truck at low speed or by the less heavy truck at high speed, is not particularly worrying engineers as a pavement problem.

What are these excessive truck loads? Naturally the answer varies for different cities. In most instances it is not based on determined facts but is merely an estimate from observation. A few of the more definite figures obtained are as follows:

Seattle, Wash.—The extreme truck load is an oil truck which gives a combined load of 15 tons; 12-ton truck loads are common. These trucks constitute about 7 per cent of the total.

Minneapolis, Minn.—Truck loads of 15 to 20 tons travel the streets. They constitute a very small percentage, probably not over 1 per cent, of the total trucks.

Newark, N. J.—The heavier trucks weigh from 6 to 8 tons and carry loads of 5 to 10 tons, giving total loads of 11 to 18 tons. No records are had of the relative numbers of these trucks.

Philadelphia, Pa.—Gross truck loads are limited to 14 tons but it is fair to assume, however, that this gross weight is not uncommonly exceeded. Heavy motor truck traffic varies from 5 to 25 per cent of the total traffic on several important thoroughfares and probably averages 10 per cent.

Cleveland, Ohio—Truck loads of 21 to 25 tons travel the streets; they are perhaps a third of one per cent of the total.

Portland, Ore.—Loads are limited to 17,000 lb., 8½ tons, but some sand and gravel trucks exceed this by about 10 per cent.

San Francisco, Calif.—Truck loads of 12½ tons commonly travel the streets; these trucks constitute about 10 per cent of the total.

Manhattan, New York City—Coal companies own trucks carrying 12 tons net and weighing 19½ tons gross. Milk companies use trucks with 15,000 lb. on the rear axle and 15,700 lb. on the trailer axle. These loads constitute probably 1 to 2 per cent of the total traffic.

Chicago, Ill.—Standard 7½-ton trucks are common (about 10 per cent) and it is estimated that they are generally overloaded about 20 per cent.

St. Louis, Mo.—Trucks with gross loads of 12½ tons constitute about 1 per cent of the total.

In brief, 15 to 20-ton truck loads at times or somewhat commonly travel the streets of large American cities. In number, these excessively heavy trucks are probably less than 1 per cent of all vehicles using the streets.

Nature of Damages—Segregation of the damages to pavements by these very heavy trucks and by truck traffic in general is not made in city records. Observations by the street officials indicate the following effects on pavements of heavy truck loads.

In Detroit, heavy truck traffic has broken down asphalt pavements with 6-in. concrete base in spots where the subgrade was unstable. In Seattle pavements have broken down at expansion joints and also where the base or surface was raised because of expansion. In Minneapolis pavement base has been crushed and destruction of the surface has followed. In Newark the heavy loads have caused depressions where the soil under the pavement base is soft; the surface wear from heavy trucks is not excessive. In Philadelphia heavy truck op-

eration is breaking down both surface and foundations. Asphalt, brick pavement and wood-block surfaces have suffered to a considerable degree and other types to a less extent. Concrete foundations have not generally suffered except where poor subgrade conditions existed. Broken stone and Telford foundation have been churned up following spring thaws in many portions of the city where natural drainage conditions are poor. Cleveland is one city which reports no pavement damage from heavy truck loads, 21 to 25 tons. San Francisco reports excessive rutting of asphalt pavements adjoining car tracks. In Manhattan, New York City, these heavy loads, if carried on steel tires, cut ruts in the asphalt pavements or shatter the granite pavements especially if moved at high speed. In Chicago, in the easily-moved clay subsoil, there is excessive wear and the concrete foundations break down. St. Louis records no unusual pavement damage but mentions excessive vibration in buildings adjacent to rough pavements.

Premised on the foregoing statements and other information collected, the effects on pavements of heavy truck loads exceeding 12½ tons are as follows: (1) With rubber tires, surface wear is not materially increased; (2) Surface damage, particularly of soft surfacings, is evident by increased rutting and shoving; (3) broken stone bases are crushed and dislodged; (4) concrete bases 8 in. or less in thickness are frequently broken down; (5) Soft or unstable subsoil aggravates base damage; (6) High speeds of heavy trucks augment all these injuries.

Limitations of Traffic—Except from park drives and boulevards, trucks are not excluded from any street in any of the cities studied. Expressed another way, trucks are not excluded from any street for any reason except traffic requirements; they are free to travel on pavements of any classification, and on any street—residential or business.

Regulatory Practice—Few cities are without some sort of legal regulation of vehicle loads. It is notable that two very large cities, with heavy truck traffic, Manhattan, New York City, and Detroit, Mich., have no legal regulation of truck loads although in Manhattan an ordinance is now before the Board of Aldermen which limits truck loads to "25,000 lb. gross weight, 8 ft. in width and 28 ft. in length, including load." Local ordinances exist in some cities and others operate under the general motor vehicle act of the state. The legal limitations vary greatly and some of them are obviously relics of the days of horse-drawn vehicles. A few examples indicate practice.

San Francisco, Calif.—Carrying loads in excess of 15,000 lb. is unlawful except that single articles in excess of 15,000 lb. may be carried by special permission. There is an ordinance regulating tire widths, viz.: Not less than 3 in. for 4,000 to 7,000 lb., and 4 in. for 7,000 to 10,000 lb. Ordinances are executed by the police department and the Board of Public Works. A new ordinance setting the maximum truck load at 25,000 lb. is contemplated; this will bring the regulations into conformity with the average heavy loads reported previously.

Chicago, Ill.—A committee of engineers of several city departments has the task of revising the present truck and trailer load restrictions. These are: Total gross load 30,000 lb.; total on any axle, 24,000 lb.; and total per inch width of rubber tires, 1,000 lb. The new ordinance when passed becomes a police regulation.

Cleveland, Ohio—Load regulation is in charge of the street division of the Department of Public Service. The load limit is 12 tons.

Philadelphia, Pa.—All vehicle loads are restricted under the state motor vehicle act of 1919. General responsibility for all traffic regulations lies with the Police Bureau of the Department of Public Safety but little or no work has been done on weight regulation.

Newark, N. J.—Vehicle loads are regulated by the State Motor Vehicle Department under the motor vehicle act. This act restricts the load to between 500 and 700 lb. per inch width of tire depending upon the wheel diameter. There is also a speed restriction of 16 miles per hour for 6-ton load and 10 miles per hour for 15-ton loads.

Seattle, Wash.—State laws and city ordinances provide that the gross weight on any axle shall not exceed 22,700 lb. Execution is in the hands of the Streets and Sewers Department which, however, has no equipment for weighing load but must depend upon the state highway department.

Minneapolis, Minn.—A city ordinance puts the maximum load at 28,000 lb., and 800 lb. per inch width of tire. The execution of the ordinance is in the hands of the city engineer. Two loadometers have recently been purchased and it is planned to put two men at work weighing vehicles on the streets.

St. Louis, Mo.—Loads are restricted to 28,000 lb. gross, 22,400 lb. on one axle and 800 lb. per inch width of tire. The department of streets and sewers executes the regulations through a special inspection.

None of these specific figures is of particular significance but together they indicate (1) That there is no close agreement in thought of what vehicle loads should be or of how they should be designated, (2) that there is similar uncertainty of thought in respect to who or what department should have the regulation of vehicle loads, and (3) that almost no city has the organization or equipment to detect violations of load regulations and enforce obedience to them.

Remedial Plans—Except a few cities, perhaps five of twenty which express themselves as contented with their present practice, there is general development of plans to meet heavy truck loads by changes in pavement design and types. The following are some of the plans:

Chicago, Ill.—On through streets new pavement base has been increased from 6 in. to 8 in. of 1:3:5 concrete, with an asphalt surface course of 1½-in. binder and 2 in. of top.

New York (Manhattan)—The failures of foundations are increasing and an increase in strength is being considered but whether by changing the thickness or the proportions has not yet been decided.

Philadelphia, Pa.—The city is replacing as rapidly as possible all old granite block-pavement on gravel base and asphalt pavement on broken stone base. On narrow streets carrying heavy truck traffic the tendency is to substitute granite blocks for other types. Variations in the structure of street asphalt pavements have been made experimentally during the present season (*Engineering News-Record*, Sept. 28, 1922, p. 621) with a view to increasing the stability of this type of pavement under heavy truck traffic.

Detroit, Mich.—In 1920 the thickness of concrete base was increased from 6 to 8 in.

Seattle, Wash.—In laying all concrete a new method of seasoning has been adopted. Concrete is sprinkled for the first ten consecutive days following the laying, as tests in the laboratory have shown and observations in the field have indicated that greater strength is thus obtained. A mixture of 1:2:3½ is used in all one-course concrete pavements, and a mixture of 1:3:6 is used in concrete base for brick, asphalt, sandstone, granite or wood block. The thickness of the one-course concrete pavement is governed by traffic conditions, 9 in. of material being used on extra-heavily-traveled streets, while 6 in. is used in alleys.

St. Louis, Mo.—The division of design has adopted greater thickness of concrete base and is not constructing any soft surface roadways except on purely local traffic streets.

In pavement design then, as the result of heavy truck loads, two lines of development are noted: (1) Strengthening of the base by increased thickness or stronger material, and (2) strengthening the wearing surface to resist rutting and shoving.

Conclusions—A review of truck loading and overloading in large cities leads to the following conclusions:

1. City pavements generally as constructed in the last ten years will break down comparatively rapidly under the extreme truck loads of 15 to 25 tons which now prevail to some extent in most large cities.

2. Two ways of correcting the condition appear practicable: (a) prescribing by law reduced truck loads and vigorously enforcing the law, and (b) strengthening pavements and foundations to resist truck travel of the weights stated.

3. Logical load regulation implies in addition to general weight limitation provision that heavier trucks may travel designated arterial business streets, that is, routing of traffic according to load is an essential part of load regulation in city streets. This would help to lengthen the life of pavements on thousands of streets where lack of funds prevents rebuilding for many years.

4. Successful load regulation implies direct and absolute authority to enforce the established restrictions through a division or bureau organization adequately manned and provided with equipment to make load determinations and exercise police authority.

Manganese Deposit on Water Filter at Breckenridge, Texas

By John B. Hawley
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and
W. S. Mahlie,
Chemist-in-charge of Water Filters, Breckenridge, Texas

Abstract of paper before Texas Section, Am. Soc. C. E.

GROWTH of crenothrix manganifera in a force main while standing idle for three weeks is believed to have been the cause of a black, greasy deposit consisting largely of manganese which occurred last year on the sand of the mechanical filters of the water-works supplying Breckenridge, Texas.

New works for this place were built in 1921 by the Walker-Caldwell Water Co., after plans by the senior author of this paper. The main source of supply is from impounding reservoirs on Clear Fork. This is supplemented by water from another impounding reservoir, which also affords storage for Clear Fork water. The Clear Fork supply is pumped through ten miles of 16- and 12-in. cast-iron pipe to a receiving reservoir and second pumping station in East Breckenridge. When there is a plentiful supply in Clear Fork the pumps are worked to their full capacity of 2.5 m.g.d., and the surplus 1.8 m.g.d. excess over the demand is forced to the supplementary reservoir.

Late in 1921 a decision to install mechanical filters was reached. On Jan. 28, 1922, two 0.5-m.g.d. units, having normal filter sand, were put in use. For some weeks Clear Fork water was applied to the filters but later on the Clear Fork pumps were shut down and the force main left standing full for three weeks. Meanwhile Lake Grande was drawn upon. Early in June, when the Clear Fork supply was plentiful, water from that source was pumped through the main direct to the filters. When the water from the river was turned into the preliminary basin, it had a bluish-black inky appearance. When after coagulation and sedimentation the water was applied to the filters, it left a black greasy looking deposit, although the filter effluent was clear and colorless. In a short time, large cracks appeared on the surface, and, upon washing, this black deposit apparently was not disturbed although the mud on the filter was wholly removed by usual washing. The sand also appeared to form in lumps or masses like the usual "mud balls." When washed, the lumps apparently turned over without disintegrating.

Upon examination, it was thought that the sand was coated with a deposit of oily or asphaltic materials, as Breckenridge is the center of a vast oil field, draining into the Clear Fork. A number of solvents—carbon disulphide, carbon tetrachloride, naphtha, alcohol, ether and chloroform—were tried without removing the deposit from the sand. The residue was, however, soluble in citric acid.

A portion of the sand was placed in a large casserole of distilled water and rubbed very thoroughly with the fingers until much of the black deposit was loosened. These washings were then decanted from the remaining sand and evaporated to dryness. An analysis of this air-dried residue showed the following results:

	Per Cent
Ignition loss	29.34
Silica, SiO_2	25.26
Alumina, Al_2O_3	18.21
Iron oxide, Fe_2O_3	4.89
Calcium oxide, CaO	2.55
Manganese oxide, MnO*	19.71
Total	99.96

*The manganese is reported as MnO but this was the state after oxidation by ignition. Undoubtedly the manganese in the raw water was a hydrated oxide in various states of oxidation.

The origin of the manganese still being unaccounted for, an analysis of the pipe coating was made. This showed no manganese. Clearly then, the manganese came from the water. A number of river-bed stones were examined and all of them showed the presence of manganese, some in rather large amounts. (At the headwaters of the river, in Dickens County, about 140 miles northwest of Breckenridge, there are several pyrolusite deposits almost large enough to warrant mining operations.) It was then assumed that the black deposit was the result of the action of a species of the higher bacteria, known as Crenothrix manganifera and after some correspondence it was definitely concluded that this was the case.

The water had been lying in the pipe line for a period of three weeks prior to its use at the filter plant, with every condition favorable for the development of this species of organism. The water was somewhat deficient in dissolved oxygen, high in organic matter and temperature and was in the dark. Somewhat later, the water was examined for manganese which was found to be present to the amount of 0.036 p.p.m. No further trouble was encountered.

No similar occurrence of manganese in the state of Texas is known to the writers.

On account of the high cost of replacing this "black" sand ($12 per ton) some experiments were made to find a means of dissolving the coating. One of the filter plant operators found it to be soluble in lemon juice. Laboratory tests with "citric" acid having given fair results an attempt was made to dissolve the coating "in situ." The acid appeared to "cut" only a small part of the coating, unless used in a very concentrated solution. Dilute solutions appeared to have little or no effect. Concentrated solutions attacked rapidly but for a very short time only. Clearly, the expense of citric acid treatment would exceed that of new sand.

Railway Mileage of the World

The railways throughout the world had an aggregate length of 748,000 miles in 1920, according to a bulletin of the National Association of Railway Executives. This mileage is distributed as follows: North and South America, 380,194 (or 50.8 per cent); Europe, 237,888 (31.8); Asia, 74,110 (9.9); Africa, 32,239 (4.3), and Australia, 23,569 (3.2 per cent). The United States has a total mileage of 264,373 miles, or 35 per cent of the world's mileage.

Importance of Oxygen and Stirring for Activated-Sludge Growth

Tests Indicate Forced Aeration Unnecessary as Little Oxygen Needed—Air, Suspension and Stirring Factors Evaluated

HOW to reduce air consumption to a minimum consistent with good results is one of the vital economic problems in the treatment of sewage by the activated-sludge method. Earlier investigators, mostly engineers, have attempted to replace the stirring action of the air by mechanical means. They failed largely. (See Coulter, W. S., "Air Diffusion in Activated Sludge," *Engineering News-Record*, May 3, 1917, p. 255; Brosius, A. M., "Activated Sludge Novelties at Hermosa Beach, Calif.," *Engineering News*, Nov. 9, 1916, p. 890; Orbison, R. V., "Tests of Trent Activated-Sludge Device at Pasadena," *Engineering News-Record*, Dec. 30, 1920, p. 1287; and Nordell, C. H., "Mechanical Agitation of Sewage Proved Unsuccessful," *Engineering News*, Nov. 2, 1916, p. 856.)

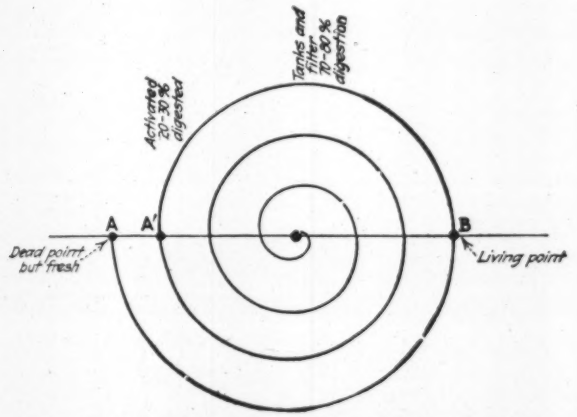


FIG. 1—SPIRAL ILLUSTRATION OF THE CYCLES IN DIGESTION OF SLUDGE

A represents fresh solid organic matter. At *A'* is activated sludge, 20 to 30 per cent digested. The outside of the central dot represents the effect of tanks and filters wherein the organic matter is digested to inert humus. To obtain maximum fertilizer value of sludge it is essential to "pick" it on the first return to *B*, the point of living stability.

Haworth at Sheffield, England, in his circulation tanks, 4 ft. wide and 4 ft. deep, effects activation without aeration but about as much area is required as for tanks and filters. Nordell concluded that so much air is required for oxidation that it will furnish all the agitation necessary but he defined no other condition than air as necessary for the growth of activated sludge. Subsequent investigators, with few exceptions, seem to have accepted Nordell's conclusion, and to have been discouraged from further experimental work along this line.

After the microscopic investigation of the organisms occurring in activated sludge reported in *Engineering News-Record*, Jan. 18, p. 119, Dr. A. M. Buswell, chief, Illinois State Water Survey, concluded that possibly Nordell's conclusions were in error because of confusion over the rôle of the various factors. Dr. Buswell set up experiments to evaluate the factors which air accomplishes when it is blown into the aeration chamber. Results of his studies, which attack the problem from the biological and chemical standpoint, are given as follows in a paper presented recently to the Illinois Society of Engineers:

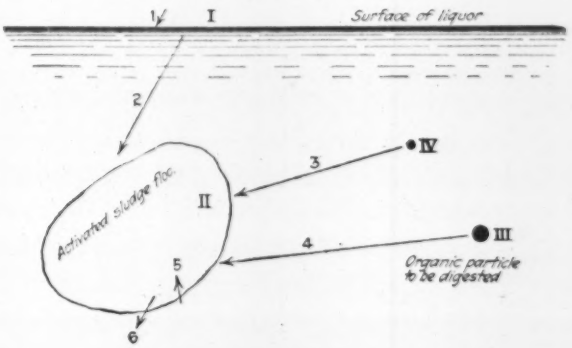


FIG. 2—GRAPHICAL REPRESENTATION OF THE SIX PROCESSES IN DIGESTION OF SLUDGE

1. Oxygen rapidly enters skin of liquid. 2. Slow process of getting air to organic particle. 3 and 4. Also slow diffusion process of getting dissolved molecules and colloids to particle. 5. Comparatively rapid action of digestion by organisms of the sludge floc. 6. By-products of biological growth must diffuse away to prevent poisoning the growth. This is a slow process.

The Sludge-Digestion Spiral—In nature organic matter is worked over by succeeding generations and races of micro-organisms until a large percentage of it has been broken down to ammonia, nitrates and carbon dioxide, leaving a relatively small amount of black humus as a residue. The course of this reaction might be represented by a spiral. Suppose at a point *A* we start out with the dissolved and colloidal organic matter in sewage. Microbial spores thus develop producing bacteria, molds and sometimes even higher forms whose nourishment is drawn from the organic matter, until when we arrive at point *B* all of the organic matter has been taken up to form the living substances of the growths which develop. If these growths continue their life processes they produce a certain amount of carbon dioxide and ammonia and then eventually die and decompose bringing us to the point *A'*, where we again have dead and more or less liquefied organic matter. The distance from *A* to *A'* would represent what some authorities refer to as the "wet-burning" or "moist combustion" which has taken place during the first lap around the spiral. If we continue to go round and round this spiral we eventually arrive in nature at a condition where a fairly considerable portion of the organic matter has been mineralized and a black stable humus substance remains.

Sewage treatment by means of biolytic tanks, sprinkling or contact filters and subsequent secondary tanks gives us practically the result indicated by the spiral. The heavy solids are attacked and worked over by certain groups of bacteria in the sludge digestion chamber of the biolytic tank until practically nothing but a black humus remains. The liquefied product, together with the colloidal and dissolved organic matter in the sewage, is taken in by the organisms of the biological jelly on the sewage filter. In this jelly the same spiral of activities goes on. A cross-section cut with a knife through the growth on the sewage filter stone shows on the outside the new whitish growth composed of various types of bacteria and protozoa. Just below this new growth there is a layer of less active and dying or dead bacterial filaments upon which varieties of protozoa are feeding. These protozoa in turn die and various forms follow, undoubtedly, including some of the same anaerobic forms which are active in the sludge digestion chamber of the tanks, which produce immediately adjacent to the stone a black stable humus. From time to time this humus sloughs off and is finally worked over in the digestion chamber of the secondary tanks. As a result of allowing this process to go on to the limit we obtain a relatively small amount of comparatively inoffen-

FIG. 3—DIPPING RACK

Aeration and stirring were produced at the same time. The rate at which oxygen was taken in was determined by substituting oxygen free water for the sewage.

sive sludge. The process, however, requires rather a large area for its practical application.

In the Activated-Sludge Process, however, we apparently start out with the idea that the sludge is a valuable fertilizing material and therefore for the most economical operation of the process we should try to get as much sludge as possible. Since it is a biological process the course of the reaction will be along the course of the same spiral described above. But since we are going to considerable expense in order to provide a condition favorable for the growth of the microscopic life, namely, by blowing air into the sewage, we will waste considerable effort if we allow the process to proceed very many laps around the spiral. The most efficient process would seem to be one which removes the sludge as near the point *B* as possible; that is as soon as a luxuriant growth has been developed and before any of this growth begins to die and decompose. This fact is the fundamental distinction between tank-and-filter treatment and activated-sludge treatment, the object of the former being to go round the spiral approaching the center as nearly as possible, that is with the maximum of wet-burning, while the latter should go only to the point *B*.

There is also a mechanical difference between the activated-sludge process and the tank-and-filter system. Hering has shown that the amount of purification is proportional to the surface exposed. Since it is necessary to use rather large stone in filters to avoid ponding it is obvious that the ratio of surface to volume, that is the efficiency per cubic foot, is comparatively low, while in the activated-sludge process the floc surface is relatively enormous, being in the neighborhood of 500 sq.ft. of surface area per cubic foot of aeration tank volume.

The organisms which we see composing activated-sludge flocs we have also seen growing in stagnant pools and ditches and along polluted streams where we are sure the oxygen available was far below that which seems to be necessary for the activated-sludge process. This observation leads to the very pertinent question as to whether oxygen is as essential to the success of the activated-sludge process as it is now considered to be. We are unable to find any direct evidence on this point because in every case the air blown into the sewage or the mechanical force applied, as in Haworth's case, was producing several different effects, any of which might obviously be of fundamental importance to the success of the process.

What Diffused Air Does—When air is blown into the aeration chamber of an activated-sludge plant it does three things: (1) It maintains the sludge in suspension. (2) It maintains aerobic conditions. (3) It stirs up the mixture, allowing fresh liquor to come into contact with the sludge. We are not able to tell, therefore, which one of these three factors determines the critical minimum air requirement. In Haworth's process we also have the same three factors determining his critical velocity, namely, 1½ ft. per second, which he found necessary to maintain in his circulating chamber. The importance of maintaining the sludge in suspension depends upon the fact that otherwise the sludge could not come into contact with the liquid and second, that if the sludge is allowed to stand it very soon begins to putrefy and the work done in building it up is lost; in other words, the reaction starts to go on around a lap or two on the spiral. The relative importance of aerobic conditions and stirring cannot be balanced by means of any present data. Accordingly we have undertaken an investigation to determine the minimum air requirement of the microbial growths composing the sludge. To do this it was necessary to hold one at least of the three variables constant, thereby allowing us to balance the other two.

Mechanical Methods of Sludge Suspension and Oxidation—We decided upon adopting some mechanical means for maintaining the sludge in suspension thus making it possible to balance the relative importance of stirring and oxygen requirement and to obtain data on critical stirring velocities and minimum oxygen necessary for biological growth. The necessary experiments were carried out in small tanks of approximately 12-gal. capacity. Various materials, such as strings, copper, zinc and iron gauze, were used to support the sludge while arrangements were made for circulating and aerating the sewage. A few rough experiments carried on more than two years ago had demonstrated that the organisms ordinarily forming activated sludge would quickly attach themselves to and grow upon any suitable surface placed in the sewage.

In the first experiments these sludge holders or nidus racks were dipped in and out of the tank containing the sewage, thereby producing aeration and stirring at the same time. The amount of oxygen introduced in this manner was determined by observing the rate at which water containing zero dissolved oxygen became aerated when substituted for the sewage. It was impossible to determine the rate of aeration of the sewage directly since some of the oxygen is used as fast as it is taken in. In another set-up we provided our tank with a filtros plate

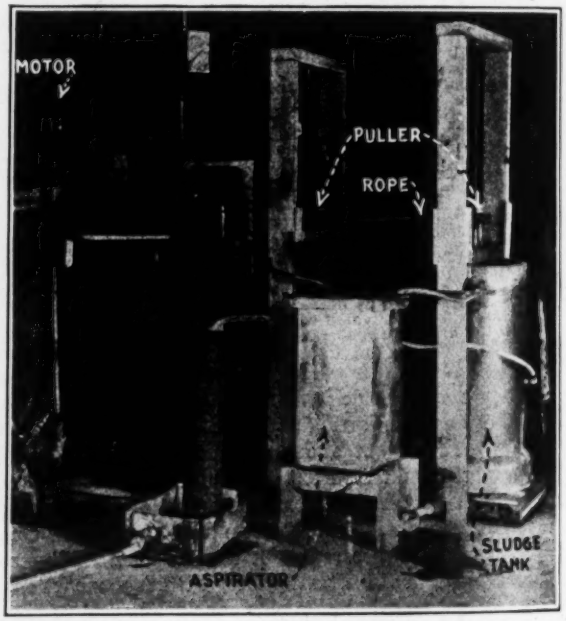


FIG. 4—TANK WITH FILTROS PLATE AND ROTATING NIDUS RACK

Gallows frame over tanks made from clay pipe supports pulleys on shaft carrying nidus rack. Pulleys are actuated by rope driven by small motor.

in the bottom and a rotating nidus rack. Previous experience with the dipping rack had shown that the amount of air required was comparatively small. We therefore arranged to feed air in very small quantities by means of an aspirator bottle. As a result of several such experiments we were able to produce an abundant growth of sludge, very good clarification and a substantial purifica-

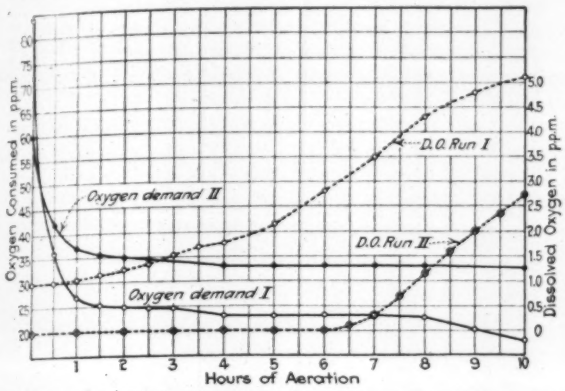


FIG. 5—RELATION BETWEEN OXYGEN CONSUMED, DISSOLVED OXYGEN AND TIME OF AERATION WITH NIDUS RACK MAKING 16 DIPS PER MINUTE

On raw sewage oxygen consumed was determined on the unsettled samples. Samples taken during the aeration were settled one hour before running oxygen consumed.

tion of sewage in from three to six hours when using as low as 0.002 cu.ft. of air per gallon. Finally we abandoned forced aeration altogether and have repeatedly been able to remove from strong domestic sewage 30 to 50 per cent of the difficultly removable "colloids" (*i.e.*, substances not removed by two to three hours sedimentation) without introducing air other than by gentle stirring. Purification results were judged by turbidity and O_2 from $KMnO_4$ tests. In other words as long as sludge is not allowed to settle down in the bottom of the tank and putrefy and as long as circulation is maintained activated sludge will grow and develop at oxygen levels so low that they can scarcely be measured. Stirring apparently is very much more important than is oxygen.

Why Stirring Is Important—If we consider the various steps which must take place in the activated-sludge process it will be apparent why stirring is of such great importance. There are apparently four important points involved in this process, each of which we will represent as follows: (1) The water surface, by a straight line; (2) an activated-sludge floc, by a rough oval; (3) a colloidal particle of organic matter, by a large dot; (4) a dissolved molecule of organic matter, by a small dot. We shall discuss the process in terms of six reactions. (1) The air must saturate the liquor or water immediately below the surface of contact. Langmuir has shown that enough molecules strike such a surface to saturate it in an infinitesimally short time, giving us a thin layer of water saturated with oxygen immediately in contact with the air surface. (2) This oxygen must then diffuse to the activated-sludge particles. This is an exceedingly slow process, as was pointed out more than twenty years ago by Noyes and Whitney and later emphasized by Phelps. (3) The dissolved molecular or organic stuff must diffuse to the activated-sludge particles. This also being a diffusion process is slow. (4) The colloidal particles must get to the activated-sludge floc somehow or other. The actual change of position of colloidal particles is practically zero. (5) The organic material and the oxygen must be taken up and worked over by the organisms of the sludge floc. As far as we are able to tell this is a comparatively rapid process. (6) The by-products of the biological growth must diffuse away from the sludge floc; otherwise they will accumulate and poison it.

Of the six steps which must take place, all except (1) and (5) are comparatively slow. The only way that we can speed up the other four steps in this process is by stirring. Stirring will sweep away the saturated film from the air surface and bring it down in contact with the activated-sludge particles. It will move the dissolved and colloidal organic matter about so that they come in contact with the floc and will sweep away the metabolic products of the sludge organisms. In view of this analysis it does not seem so strange that stirring should prove to be more important than air in the carrying out of this process. Stirring by means of blowing air through sewage is, however, a rather inefficient process. We do not get as much stirring for the power input as we would if the power were applied in some other way. When air is blown into sewage, the activated-sludge flocs, air bubbles and liquid are all driven in the same direction. The most efficient process would be one in which the air surface and flocs would be held stationary while the liquor is caused to flow past them. The experimental apparatus which we have used approaches some such condition and it is for that reason that we were able to obtain the results described.

Propose Restudy of Pan-American Railway Project

Proposed Route from Colombia to Argentina Would Tap Vast Region and Enable Connection With Many Existing Lines

BY FRANK B. MORRIS
Civil Engineer, Liberty Engineering Corp., New York City

DEVELOPMENTS at the International Engineering Congress recently held at Rio de Janeiro direct attention once again to the project for a Pan-American railroad to provide through rail transportation between the two American continents. Resolutions adopted by the congress express the confidence of those present in the need and practicability of the project and provide for the appointment of a commission of three members, who would arrange in turn for the appointment of a commission to consist of one member from each country of continental America, with Charles Pepper, the only living member of the permanent Pan-American Railway Commission, as chairman. It is proposed that this committee should take up at once the task of determining a commercially practicable route.

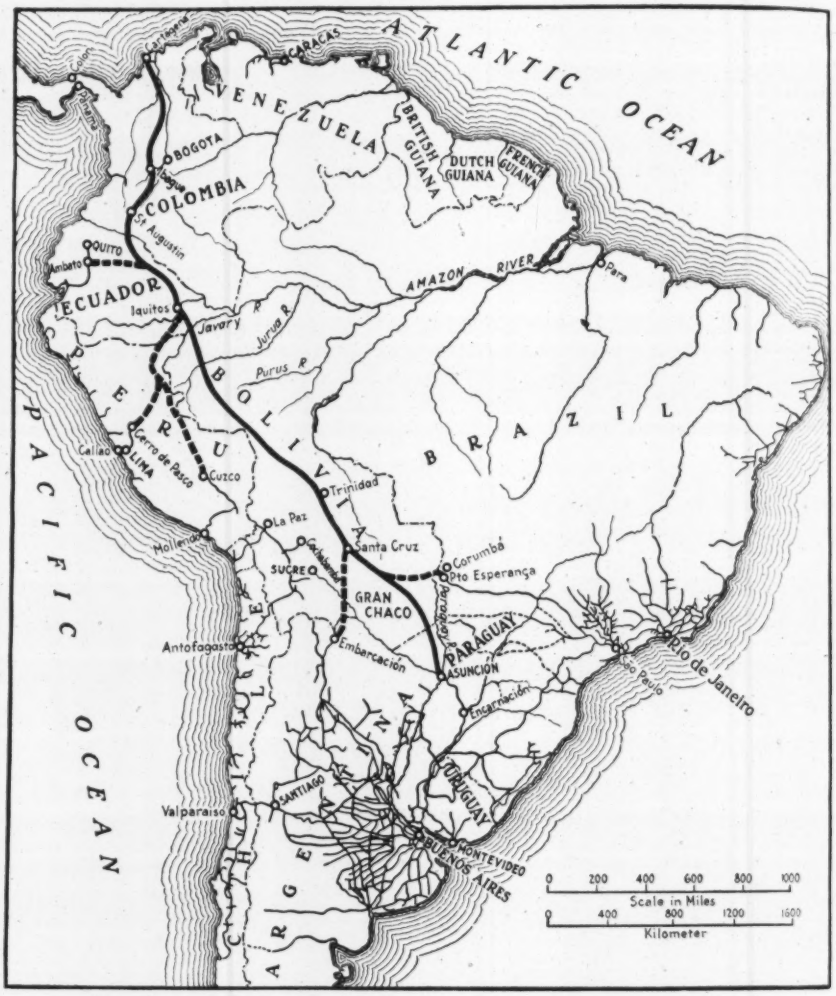
Studies made late in the nineteenth century for a line along the principal range of the Andes, using the existing railroads where their location could be considered as adhering to the general direction of the Pan-American route, developed various obstacles which resulted in the temporary abandonment of the project. The principal objections offered to this plan are as follows: Existing railroads originally were built to serve local traffic and local development. They were built to conform to topographical conditions in particular areas rather than with the intention of forming links in a through system. Grades and curvatures are prohibitive. Gages are numerous and varied. Tracks and bridges are of light steel. Distances are excessive, caused by developments for grades. Unnecessary vertical lifts have been overcome. Tunnel sections are inadequate. In many instances directions not in harmony with a north and south trunk line would necessitate an expenditure probably as great as would be required to construct an entirely new line, and the additional length that must be added to these existing lines to accomplish a reduction of grade to a maximum of 1 per cent would so lengthen the system that competition with water transportation would be impossible and the Pan-American Railroad would be nothing more than a carrier of insignificant local commerce.

An alternative route that eventually would serve every nation in South America with direct rail connection would run from the Caribbean Sea directly to Buenos Aires, passing through Colombia, Ecuador,

Peru, Brazil, Bolivia, Paraguay and Argentina. This route, the South American International Railroad, would be the ideal solution and probably would have substantial co-operation from the governments of all these nations as well as from Chile and Uruguay. The northern terminus would be Cartagena, the most important Atlantic port of Colombia; thence it would run south through the valley of the Rio Magdalena to its head just southeast of the village of St. Augustin, where it would cross the eastern spur of the Colombian Andes near the northern boundary of Ecuador at an elevation of approximately 6,000 feet.

The principal Andean range which forms the continental watershed throughout the length of South America breaks into three distinct ranges near the southern boundary of Colombia, the western or Pacific range, the central range and the eastern range, on the western slope of which is located the city of Bogota, capital and principal city of Colombia. The western range extends northward through the Isthmus of Panama, forming the watershed between the Atlantic and Pacific oceans. The central range, the highest and most rugged of the three, is separated by the Cauca River from the western, and by the Rio Magdalena from the eastern range. This central range ends at the junction of the Cauca and Magdalena Rivers, while the eastern range extends northward and eastward into Venezuela, to the Caribbean coast.

That portion of Colombia along the route of the proposed railroad is rich in mineral, agricultural, forest and animal products, and although hampered by the present inadequate transportation facilities the greater part of Colombia's commerce, both foreign and domestic, originates in the immediate vicinity of the proposed line.



PROPOSED PAN-AMERICAN RAILWAY ROUTE

This location will enable connections to be made as shown with existing railways that serve all the South American countries and will tap a rich territory in eastern Bolivia and western Brazil.

From the St. Augustin Summit, the line would descend southeastward along the eastern slope of the Andes, through eastern Ecuador, a district of which little is known except that it is rich in hardwoods and virgin rubber, and has an excellent climate and fertile soil. This district is believed to contain much mineral wealth, because of specimens brought into western Ecuador by the Napo Indians.

Continuing southeastward, the line would pass through the northeastern part of Peru, crossing the upper Amazon near Iquitos, thence crossing the Rio Javary, into Acre territory of Brazil. That section of Peru traversed by the proposed line has shown remarkable agricultural development during the past few years, in spite of the heavy freight charges on the Amazon.

On entering Brazil, the line would pass through the western part of the state of Amazonas and the territory of Acre, where exist numerous towns, the principal one being Cruzeiro do Sul, the capital of Acre territory. This section abounds in virgin rubber and hardwoods, has an equable climate, and a fertile soil, suitable to the production of grain, sugar, cotton and coffee. Continuing southward the line would enter Bolivia at its northern boundary, and continue through that country to the border of Paraguay in the Gran Chaco, passing through the city of Santa Cruz, which in spite of its isolation, is a commercially important city of 35,000 urban population and about 100,000 in the district, and the fourth in importance in the republic.

The entire northern area of Bolivia offers great possibilities. The famous Yungas district and the Cochabamba valley lie a short distance west of the proposed railroad, while the route itself traverses a section rich in gold, silver, timber of all kinds, cotton, coffee, fruits

and the best quality of rubber. Surveys are now under way for the extension of the Antofagasta Railway from Cochabamba, east to Santa Cruz; a line is proposed also from Santa Cruz south to Embarcación Argentina, through the petroleum district of eastern Bolivia, thus giving another rail connection with Buenos Aires and northern Argentina, while the line from Cochabamba to Santa Cruz would give direct rail connection with western Bolivia, Peru, and the entire length of Chile, via the Chilean longitudinal railroad.

From Santa Cruz southeastward to the connection with the Paraguay Central R.R. at Asunción, the route passes through the enormous flat plain of the Gran Chaco, following the watershed between the Paraguay and Pilcomayo Rivers, and passing through a district unsurpassed for stock-raising, now inhabited only by Indians, except along the Paraguay River, where are located important towns and industries. The Gran Chaco abounds in hardwoods, the most important of which is the red quebracho from which tanning extract is produced. This product reaches its northern markets via the Paraguay River and Buenos Aires, necessitating a southbound haul of from 1,000 to 1,500 miles.

At Asunción connection would be made with the Paraguay Central-Entre Rios system, as before mentioned, this system being a well constructed line of 945 miles length, from Asunción to Buenos Aires, built to 4 ft. 8½-in. gage, and crossing the Paraná River at Encarnación by train ferry. The present running time for trains between Asunción and Buenos Aires could undoubtedly be decreased to thirty-two hours.

Length of Line—This proposed trunk line from Cartagena to Buenos Aires would be approximately 4,450 miles in length, with a maximum grade of one per cent, and with only one lift of importance, that at St. Augustin pass, and capable, therefore, of maintaining a running schedule that would enable trains to make the trip between termini in 168 hours, or seven days. Of this 4,450 miles total length, deducting the Paraguay Central-Entre Rios division of 945 miles, which is now in operation, there would remain approximately 3,500 miles to be built, of which 70 per cent could be cheaply and easily constructed; the section crossing the Andean Spur, about 980 miles long, being the only portion of the line where moderately heavy construction would be encountered.

In addition to the railroads now under consideration, from Santa Cruz south, and west, which will form connections with this trunk line, there is in Peru a project to extend the Cerro de Pasco Railroad east to Amazon navigation. This could easily be extended further to a junction with the South American International R.R. at Iquitos, thus connecting the proposed line with Lima, the capital, and Callao, Peru's most important Pacific port. The Cuzco branch of the Peruvian Corporation R.R., now being extended into the Amazon district, would form another feeder, giving connection with southern Peru and western Bolivia. In Ecuador, a line is now under construction from Ambato eastward following the headwaters of the Rio Pastasa, a tributary of the Amazon. A short extension would serve to connect this railroad with the trunk line, thereby linking the entire Ecuadorean system to the Atlantic seaboard.

Another extension which would undoubtedly be made to form a junction with the trunk line, is from Porto Esperança, on the Paraguay River, and the present terminus of the Noroeste do Brazil Ry. This connection could be made with a short stretch of line, of cheap and easy construction, joining the trunk line in the Gran Chaco, thus furnishing direct rail communication with the cities of São Paulo, Rio de Janeiro, and all southern Brazil Atlantic ports. In addition to the Paraguay Central-Entre Rios R.R., before mentioned, other roads now in operation that would become feed lines for the South American International R.R. and furnish immediate traffic, are the Puerto Berrio-Medellin; Puerto Wilches-Búcaramánga; La Dorada-Ambalema, and the system operating between Ibagúe and Bogota, all in Colombia, which were primarily constructed for local development.

The proposed South American International Railroad would cross the following rivers now open to navigation, which would furnish other commercial routes of great importance in the exploitation of the Upper Amazon forestal resources: Rio Marañon or Upper Amazon, Rio Javary, Rio Jurua, Rio Purus, Rio Madre de Dios, Rio Beni, Rio Mamoré and the Rio Paraguay. These rivers with the several existing railroad lines would greatly facilitate railroad construction, enabling this work to proceed simultaneously at no less than twelve different points.

Climate—Climatic conditions along the route are favorable. The season of rains occurs during November, December, January and February, and the temperature varies between an annual average of 55 deg. F. on the Colombian plateaux to 70 deg. in the Bolivian and Paraguayan plains, and 82 deg. in the lower Magdalena valley, where the rainy season extends from June to November. The railroad route lies west of the fever district of the Amazon basin, and at only two points is to be found any evidence of fevers. In the lower Magdalena valley and northern Bolivia there is a mild form of malaria, which readily yields to simple treatment.

The following table of comparisons will give an idea of the saving in time between New York and a few of the principal South American cities, by the construction of the South American International R.R. The sailing time over the ocean routes is based on 18-knot steamers.

City	Present Time, Days	Time via S. A. I. R.R., Days
Buenos Aires	18	12
Montevideo	17	12
Asunción	20	10
Corumbá (Brazil)	26	11
Santa Cruz	25	9
La Paz	15	11
Iquitos	24	7
Bogota	15	6

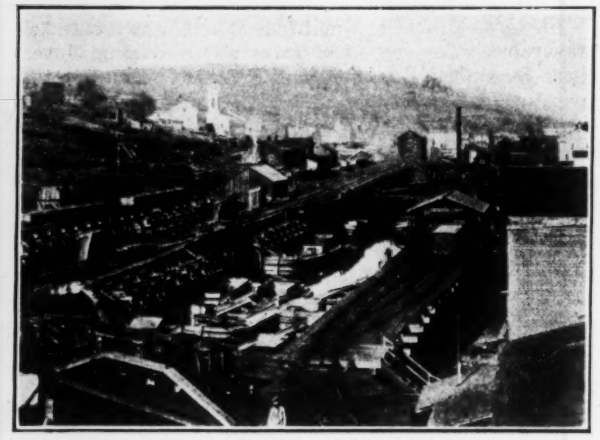
Exclusive of the Indian population, there are at present located within fifty miles of the proposed South American International R.R., between Cartagena and Asunción, approximately 2,750,000 inhabitants from which to draw labor for construction and foodstuffs, which would be readily produced as soon as the demand is created. With this nucleus, and by intelligent effort to colonize this area while the present spirit of unrest throughout Europe and Asia tends to increase emigration among the peasant classes, together with the substantial inducements to immigration that all the South American nations are offering, it seems natural to assume that the present population would be increased by more than 2,000,000 after ten years, or after completion of the railroad. Under these conditions, the natural result would be the rapid development of a district rich in natural wealth and resources.

Engineering in the Early Days of the Delaware & Hudson

Some Unusual Items in the History of Engineering Progress Recalled by the Celebration of the D. & H. Centennial

CONSIDERABLE interest has been aroused in the transportation situation in this country during the early part of the nineteenth century by the information given out by the Delaware & Hudson Co. at its recent centennial celebration. Out of the whole mass of data which the company's historians have collected the following items were selected as being of peculiar interest to engineers.

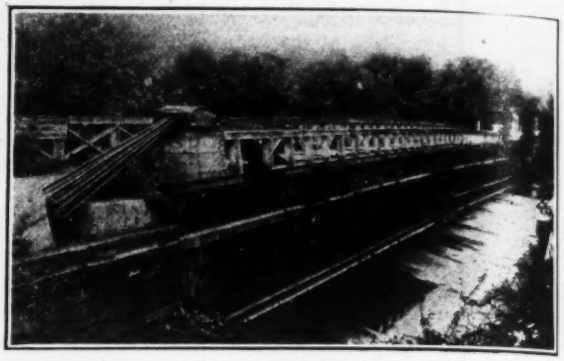
Previous to the war of 1812 anthracite coal, as a commercial necessity, was practically unknown. But during the war the stoppage of all importations of coal from England made it necessary to find new sources of fuel in this country and stimulated interest in the so-called "stone coal" which up to that time had been little more than a curiosity. It was this condition of affairs that in 1814 started the Wurtz Bros., prosperous Philadelphia merchants, prospecting for coal in the Lackawanna River valley. After nearly eight years of arduous work they



DOCKS AT HONESDALE, PA.

opened a coal mine at Carbondale, Pa., and shipped their first lot of coal down the Delaware to Philadelphia only to find that market already supplied by coal from the nearer markets on the Schuylkill and Lehigh. Undaunted by this reverse they set out to find a way to reach the New York market, and after a good deal of reconnaissance they discovered that, except for the high ridge of land separating Carbondale from the valley of the Lackawaxen, there were no insurmountable difficulties in the way of constructing a canal to the Hudson at Rondout. With this object in view they first obtained authority from Pennsylvania to canalize the Lackawaxen and then went to New York City to enlist the aid of influential men there in raising the necessary capital, and in obtaining authority from the state of New York to build a canal across to the Hudson. They succeeded in both undertakings. On April 23, 1823, the Delaware & Hudson Co. was incorporated by the state of New York, and in January, 1825, $1,500,000 of the company's stock was issued and immediately over-subscribed.

In 1823 the company had engaged Benjamin Wright, one of the principal engineers of the Erie Canal, to pre-



A SUSPENSION AQUEDUCT OF THE CANAL
This picture was taken some years after the canal had been abandoned. It shows the inside of the aqueduct, and one of the cable anchorages.

pare plans and estimates for the proposed canal and to devise a scheme for getting coal from Carbondale over to Honesdale, the proposed western terminus of the canal.

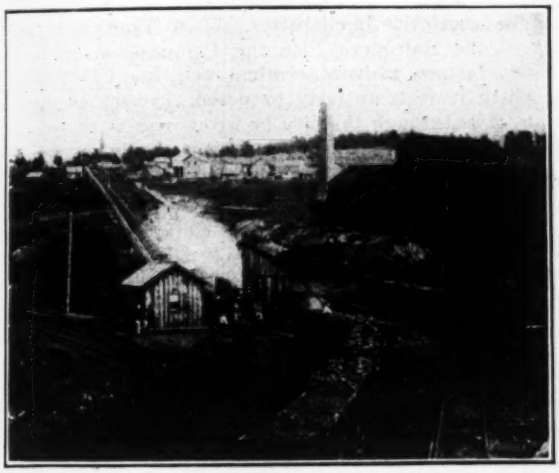
Construction work on the locks was begun in 1825, but general construction on the canal proper did not start until 1827. By December, 1828, the canal was completed and the first boats had come through to tidewater at the Hudson.

But the items in the early construction of peculiar interest to the engineer are not in connection with the canal; they are, rather, in some of the details of the incline railway which J. B. Jervis, who succeeded Benjamin Wright, had designed as a means of getting over the ridge between Carbondale and Honesdale. The general scheme of this railway was a series of steep planes connected by low-grade planes wherever the ground formation permitted. On the western side there were five such steep planes with a stationary steam engine at the head of each. By means of long chains these engines hauled from three to five loads up one track and let the same number of empties down the other track. On the eastern slope there were three steep planes down which the loads went by gravity, pulling the empties up on the other track; their speed being regulated by friction brakes on the shaft of a large fan-wheel. At the bottom of the lowest plane there was a low-grade line extending to the terminus of the canal at Honesdale. It was on this line that Wright proposed to use locomotives to move the cars.

The track construction is of particular interest in view of the present day practice. Hemlock ties 6 x 9 in. and 8 ft. long were used. These were spaced 10 ft. apart and were laid on individual piles of stone ballast wherever the ground conditions permitted. At all other places the ties were supported on posts, up to an elevation of 4 ft., or on trestles made of hemlock timbers for greater elevations. Two gains were cut into the top of each tie and rails of 6 x 12-in. hemlock 20 to 30 ft. long were set into these gains and held to the gage of 4 ft. 3. in. by hardwood wedges. Iron rail plates, 2 x ½ in., brought from England, were secured to the top of the wooden rails by screws spaced 18 in. apart. The screw holes were elongated to allow for expansion. (This type of rail was continued in use for a number of years but it was later found necessary to substitute spikes for screws and to put a hardwood strip under the rail plate.)

The First Locomotives—In January, 1828, Horatio Allen was sent to England to buy four locomotives, and the iron plates to cap the rails. He bought one locomo-

tive, the *America*, designed and built by George Stephenson, and three of a different type built by Foster Rostrick & Co. of Stourbridge. The *America* and one of the Rostrick engines, the *Stourbridge Lion*, were the first locomotives to arrive in this country. They were set up for demonstration purposes in New York and then, some weeks later, were loaded on canal boats for shipment to Honesdale. After the locomotives arrived at Rondout all record of the *America* ceases. Its disappearance was as complete as it was mysterious, until, a few weeks ago, an official of the D. & H. Co. found at the National Museum in Washington, the right-hand cylinder among what had previously been supposed to be the parts of the *Stourbridge Lion*. To add to the mystery surrounding the *America* no mention was made of it at the time the shipment arrived at Honesdale. For some reason not now clear Horatio Allen, who had ordered the two engines in England and who was charged with making the first tests of them on the track at Honesdale, selected the *Stourbridge Lion*, and on Aug. 8, 1829, had it drawn up over an incline plane laid from the canal boat to the railway track. A fire was built in the fire-box with some of the Lackawanna coal and soon there was sufficient steam to make the trial trip.



FOOT OF PLANE G AT OLIPHANT, PA.

It had been the intention of Mr. Jervis, when preparing the specifications that Mr. Allen took to England when ordering the locomotives, that they should weigh about 6½ tons and that this weight should be distributed over six driving wheels. But when Mr. Allen got to England he found so much opposition to the use of six driving wheels that he had to accept engines with four wheels instead. So when the boiler of the *Lion* was filled with water it was found that it weighed nearly seven tons and that two-thirds of the weight came on the forward pair of wheels. This was about double what Mr. Jervis had figured when designing the track. Some critical observers upon learning of this excess of weight predicted that the engine would break down the track on the trestle work; while others, noting that the four wheels were set rigidly in the frame, declared that the leading wheels would climb the outer rail on curved track and be derailed. As these gloomy predictions did not seem to be without foundation Mr. Allen decided to make the first test himself. He later stated that he was undecided whether to go slowly around the first curve or whether to take it at full speed, but finally decided that if he was to go off the trestle into the creek below he was going to do it gloriously, and so when the engine had enough steam he opened the throttle wide and was going at a good rate of speed when the engine reached the curve. The engine neither broke through the trestle nor jumped the track but continued around the curve and was soon lost from sight of the cheering spectators. Later on, however, it developed that the engine was unduly straining the track and that its continued use would soon break it down. Studies were made to see if the track could be strengthened but as the cost seemed prohibitive it was decided to build horse-ways along the side and abandon the locomotives. The *Lion* was therefore taken off the track, set to one side, and later dismembered. Many years later most of its parts were recovered and are now in the National Museum at Washington.

The incline railway remained in existence until 1899. It was greatly modified as the years passed and locomotives were again used on it much as first planned. The accompanying photographs of it were taken some years before it was finally abandoned.

One of the changes made in the canal is also of peculiar interest. Some time during the forties it was decided to eliminate the flights of locks in and out of the channels of the Rondout, Neversink, Delaware, and Lackawaxen Rivers by the construction of aqueducts across them. John A. Roebling suggested that they be of a suspension type, prepared the plans for them, and later supplied the cables and built the aqueducts. The cables for the Delaware aqueduct were 8½ in. in diameter.

Water Supply for a New City in India

In planning the new capital city for the government of India at Delhi (distinct from the existing commercial city), water supply was one of the most important features in view of the exceptionally hot and arid climate of that part of the country. It was decided to design a system which will provide for future development into a combined system serving both cities. Water will be taken from the Jumna River about ¼-mile above a polluted tributary and pumped to settling tanks from which a covered conduit will lead to filters at the present water-works plant. According to the engineer's report these filters will be of the Paterson type, as the existing slow-sand filters are not effective. These latter filters have to be cleaned frequently by manual labor and there is always the danger that the men employed in this work may be diseased and may pass on the infection to the water supply. From the clear water reservoir the water will be pumped to a main reservoir having conduits to two distributing reservoirs. Automatic valves will ensure delivery of water in proper proportions to the reservoirs. Three steam-driven Worthington-Simpson centrifugal pumps, each with a capacity of 5,000 gal. per minute under 45-ft. head, will be provided at the intake. Two Worthington steam-driven high-duty direct-acting pumping engines with a combined capacity of 3,000 to 4,500 gal. per minute at different speeds will deliver water to the reservoirs against a total head of 146 ft.

This plant will cost $2,300,000 and will furnish 30 gal. per capita for the population of 1,955 by eight hours' pumping. The distribution system is based on the same supply, with complete metering to prevent waste. Water for sprinkling streets and flushing sewers will be taken from the unfiltered irrigation water supply.

Technical Proceedings of Baltimore City Planning Conference

Eleven Papers Deal with Baltimore, Washington and Maryland Problems—Regional Planning and Zoning Given Attention

REGIONAL planning, city planning progress and practice in Baltimore, and street traffic problems with particular relation to automobile parking were features of the fifteenth annual National Conference on City Planning held at Baltimore April 30 to May 2. In addition, a number of zoning clinics were held. Of about 250 persons registered some 10 per cent or more were engineers.

Regional Planning—A lengthy paper on "Regional and Metropolitan Planning," by George B. Ford, New York City, outlined the underlying principles and reviewed the work in this field done in various parts of the United States and in other countries. Mr. Ford summarized his general conclusions as follows:

1. The character and direction of growth of contributory areas beyond the city limits should be controlled by a metropolitan or regional planning commission, or where such areas lie entirely within a county by a county planning commission.

2. Such a commission should include official delegates from each municipality affected. Each municipality should contribute to the support of the work on a pro-rata basis or if that is not feasible it should be supported by private subscription.

3. There should also be a Citizens' Regional Plan Committee composed of representatives of the leading civic and economic organizations of each community within the area. This committee should co-operate with the official commission at every stage of its work. This committee should interpret the official plans to the public and to the authorities in their respective towns and should aid in securing local backing and support. The committee should also act as a watch-dog over changing official commissions to maintain the continuity of the plans.

4. The official commission should cause a regional plan to be made which should include every physical feature which could affect more than one municipal unit. It should be made for many years to come and such a plan should be officially recognized by each of the municipalities affected by it.

5. No project affecting more than one community, be it for a thoroughfare, bridge, transit line, railroad, waterfront development, park, public or private reservation, subdivision, building code or zoning ordinance, should be executed without having received the sanction of the regional commission as well as of the local bodies affected.

6. All physical improvements affecting more than one community should be paid for by pro-rating the cost among the municipalities interested.

7. If in a given case the state constitution or laws prevent or hamper any of the above operations, steps should be taken to amend them.

8. Serious consideration should be given to the causes and the effects of concentration of population and, in so far as an undue "load on the land" is found to cause harm, the effect should be mitigated by regulation and means found of encouraging decentralization.

9. Guesswork and unscientific judgment should be reduced to a minimum in regional as well as in city planning. Every plan recommended should be the logical deduction from a quantitative as well as a qualitative analysis of all of the contributory facts.

10. Everything possible should be done to counteract the sordidness of most larger agglomerations and to bring back to the environment of the city dweller the charm that he craves.

In the course of a lengthy written discussion of Mr. Ford's paper Charles H. Cheney, Redondo Beach, Calif., said that the two important differences between city planning and regional planning are: (1) Planning for a region is a larger order, requiring broader and more imaginative planning; (2) it usually includes differing political units which create problems not so much of planning as of administration and financing. In regional planning the first great need is an airplane survey. Morris Knowles, Pittsburgh, Pa., cited the Essex Border Utilities, across the Canadian line from Detroit, as an example of getting together, first, as was done in the case of the Boston Metropolitan District, for one purpose and then taking on others. In the Canadian case water and sewerage came first and then municipal co-operation in water supply and later in plotting new areas. In a paper on "Inter and Intra-urban Traffic as a Regional Planning Problem," George A. Gamon, Pasadena, Calif., suggested major highways 100 ft. wide and one mile apart and auxiliary highways of lesser widths halfway between each major highway.

Baltimore, District of Columbia, and Maryland—Eleven papers were scheduled on various phases of the Baltimore city plan and city and regional planning for the District of Columbia and for Maryland. These were largely descriptive in character. W. W. Emmart, architect of the Baltimore Planning Commission, outlined a study for new railway terminal facilities at Baltimore in which it is tentatively proposed that the Pennsylvania R.R. through the city be given over to passenger service and the Baltimore & Ohio to freight service. Col. C. Keller, recently engineer commissioner, District of Columbia, discussing "The Relation of Washington to a Plan of the Baltimore Region," suggested among other things the correlation of the parks and parkways systems of the two cities with connecting highways, and referred to the plan that has been up from time to time for a national forest between Washington and Baltimore. Jefferson C. Grinnalds, Baltimore, in a paper on "A Regional Plan for Maryland," said that the Maryland state highway system is a skeleton on which regional planning should be built up. Water transportation facilities, especially in Maryland, divided as the state is into two parts by Chesapeake Bay, should be given careful consideration.

An analysis of the requisite area for school buildings and associated playgrounds of various classes was presented by Henry G. Perring, supervising engineer, Public Improvement Commission, Baltimore, in which he showed that altogether some 11½ acres for schools and playgrounds are needed per square mile of city territory. In congested districts it is impossible to provide so amply on account of the expensiveness of land. In a section which may change to a manufacturing district later on a heavy type of construction for school buildings was adopted so that the building could be turned over to manufacturing use later on. Among other Baltimore papers there was one on port development, by Bancroft Hill, harbor engineer, whose talk was given around a large model now exhibited in a temporary building; water supply, by William A. Megraw, water engineer; the major street system, by Maj. Joseph W. Shirley, long connected with the topographical survey of Baltimore and city planning there. The topographical survey for the annexed district of Baltimore, which has an area of about 60 sq.mi. as compared with the previous area of 30 sq.mi., was begun as soon as pos-

sible after annexation in 1918 and completed on May 30, 1921. The maps were made on a scale of 200 ft. per inch of 5-ft. contour. The survey was based on a triangulation of the United States Coast and Geodetic Survey, which co-operated with the city.

Zoning—The program announced that "Mr. Bassett will conduct zoning clinics at all free times throughout the conference." These took place at meal times and were devoted to questions and answers and an exposition of zoning principles, law and court decisions. In addition, Mr. Bassett presented a review of "Court Decisions on Zoning Up to Date" at one of the meetings.

In a thoughtful paper on "Zoning in Relation to Regional Planning," Robert H. Whitten, Cleveland, Ohio, stated that the first essential is a barrier between the large central commercial city and outside territory. The larger city in a region, as well as the satellite cities in its vicinity, should each be encircled with open space used for parks, forests, playgrounds, golf courses, cemeteries, truck gardens, or any one of many various purposes that will leave the general surface of the country undisturbed and require but a small population to conduct such operations as are carried on.

Automobile Parking and Storage—Under the title "Day and Night Storage and Parking of Automobiles," Hugh E. Young, Chicago, stated that the number of motor vehicles registered in the United States has increased from 1,700,000 in 1914 to 12,357,000 in 1923. To provide for this vast increase we have for the most part streets laid out fifty years ago.

In the Chicago district there are some 300,000 motor cars and the number is increasing rapidly. Parking facilities are available to a small handful out of the total. Shall the few automobiles that could be accommodated by parking infringe on the many that cannot? Some 45 per cent of all the automobiles which enter the business district of Chicago require one-half to one day storage. This should be provided in garages, located outside the business center.

Discussion of Mr. Young's paper was opened by John C. Long, secretary of the National Automobile Chamber of Commerce. Mr. Long said that the use of vacant lots for parking is materially helping the motor traffic situation in some cities. Many cities are finding urgent need for "parallel arteries near the present main thoroughfares to care for the growing volume of street traffic."

E. P. Goodrich, New York City, said that to allow parking on public streets is equivalent to permitting a street to be used as garages. Omaha, Mr. Goodrich said, is the only city he knows of where the streets in the business districts are wide enough for parking. J. R. Bibbins suggested the use of streets in "blighted districts" to accommodate automobiles. One-way streets, he said, afford only temporary relief. Parallel streets are needed for permanent relief. In the Springfield road tests in Illinois it was found that 35 per cent of passenger automobiles were used for business purposes. This fact must be recognized in dealing with traffic and parking problems. The possibility of underground storage for automobiles was mentioned by Mr. Bibbins. Herbert S. Swan, New York City, said that the necessary street widening to provide for present and prospective traffic would be prohibitive in many cities, but by better traffic regulations double the present traffic could be accommodated.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Compensating a Grade for Curvature

Sir—It seems to me that there is an easier method of compensating a grade for curvature than the one given by L. F. Hammond under "Four Problems in Surveying" in your Job and Office Section for April 26, p. 756. It is: Multiply the sum of the central angles in degrees (they are generally given on railroad plans) by the adopted compensation factor; to this product add the difference in elevation; divide this sum by the distance in stations to get the rate of grade on tangents. This percentage of grade is then to be decreased by the product of the compensation factor and the varying degrees for the various curves.

April 28, 1923. BENNO A. WISE, City Engineer, Bradford, Pa.

Lettering Jigs

Sir—In your issue of April 26, 1923, p. 771, under the heading "Equipment and Materials" you note a "Guide for Lettering Drawings"—the "Wrico lettering system." The note leaves the impression that this is a new system.

Similar lettering jigs have been in use in Europe for several years, and are prescribed in standard lettering on drawings by some European standards committees. I believe these jigs originated in Switzerland.

Washington, D. C., May 1. L. B. TUCKERMAN, Engineer Physicist, Bureau of Standards.

Doubt Fixation of Atmospheric Nitrogen by Activated-Sludge Process

Sir—With respect to the article appearing in your issue of March 15, p. 487, entitled "Fixation of Atmospheric Nitrogen by Activated Sludge," I should like to call your attention to the data included in an article from this laboratory entitled "Chemical and Biological Reactions in the Dorr-Peck Tank" appearing in the *American Journal of Public Health* for April, 1922. In the table on nitrogen balance our data over limited periods checks that of Mr. Peck's in that very considerable amounts up to 25 per cent of nitrogen are apparently "fixed." In subsequent experiments, the data for which will appear in our Bulletin 18 within the next few weeks, as much as 55 per cent nitrogen was apparently fixed over a 7-day period, but, on the other hand, over other periods there is apparently an appreciable loss of nitrogen, running as high as 34 per cent.

After working on this problem for a little over a year, we concluded that these erratic results are due to the accumulation of sludge in the tanks during one period and unloading in a subsequent period. Experiments on sampling the tank for the actual amount of nitrogen at any one time showed that such a procedure was exceedingly difficult, and we concluded that no nitrogen balance results were reliable unless they were run over a long enough period so that the actual amount of nitrogen in the tanks would be inconsiderable in comparison with the total amount which had gone through. When averaging the results over a period of eight months, there is found to be only an increase of 1.8 per cent.

In cases where there is considerable nitrification, it has usually been the experience that there is a greater loss of nitrogen. Our experiments were carried on with low air and without the formation of nitrates.

During part of October, November and December, 1921, we dosed the tanks with from 9 to 10 p.p.m. of iron without obtaining any fixation of nitrogen. Dr. Hague of the Department of Botany of the University of Illinois and Mr.

Long of our Division identified crenothrix in considerable quantities throughout our experiments. We have photomicrographs of our sludge.

A. M. BUSWELL
Chief, Illinois State Survey Division.

Urbana, Ill., March 30.

Sir—A study of the article by C. Lee Peck on "The Fixation of Atmospheric Nitrogen by Activated Sludge," in your issue of March 15, p. 487, leads us to make the following comments.

Some two years ago, through the courtesy of the Dorr Company, who conducted the tests at Mt. Vernon, we examined the data obtained bearing on the fixation of atmospheric nitrogen, and were also supplied with a copy of D. D. Jackson's report. We did not feel at that time, nor do we now, that these data warranted the conclusion that atmospheric nitrogen had been fixed.

Mr. Peck has not stated the period of time covered by the actual test (Test 1) upon which his conclusion is reached, nor does he state the flow. Our study of the Mt. Vernon data leads us to believe that he has drawn his conclusions from a period of eight days only, and that during this period the tanks were unloading. This will upset any reasoning on the phenomena occurring. For the period Dec. 29 to Jan. 5, the following data are summarized.

	PARTS PER MILLION		
	Raw	Effluent Tank 1	Effluent Final
Total solids	535	590	585
Suspended solids	141	212	210
Total ammonia	49.3	49.7	51.3
Insoluble ammonia	7.9	16.3	16.3

Our experience in operating the Dorr-Peck tanks has shown that where the settling compartment is agitated, as Mr. Peck states it was, it is very difficult to prevent a loss of suspended solids in excess of the daily input from the influent. Longer test periods are required than even the nineteen days—apparently the total of all tests made on nitrogen fixation at Mt. Vernon. It is entirely possible that more sludge would be discharged than was produced during the same period, and also show thereby more nitrogen in the effluent than was introduced in the influent.

The proof of such a fundamental phenomenon as the fixation of nitrogen requires careful operation and detailed sampling extending over many months, and exceedingly careful analytical work. The technique in the determination of Kjeldahl nitrogen, both soluble and insoluble, requires skilled attention and constant re-checking. Nitrogen as insoluble nitrogen is determined indirectly by difference between the nitrogen in the total and in the filtered samples. Consequently errors in both determinations affect the results for insoluble nitrogen. Excessive variations from day to day in the percentage of nitrogen in the suspended solids indicate lack of caution in checking analyses. Our experience has been that the nitrogen content of activated sludge is remarkably uniform from day to day, varying only a few tenths of 1 per cent during the course of several weeks. If this be true how can the excessive variations shown in the following table be explained? These calculations were made from the data on the blue-prints submitted to us as records of the analytical work:

	Raw Sewage			Effluent, Tank 2		
	Tons per Million Gallons		Per Cent NH_3 in	Tons per Million Gallons		Per Cent NH_3 in
Date 1919–20	Suspended Solids	Insoluble N as NH_3	Suspended Solids	Suspended Solids	Insoluble N as NH_3	Suspended Solids
Dec. 29	0.750	0.037	4.9	.894	0.089	9.9
30	.471	.034	7.2	.562	.056	9.9
31	.417	.047	11.2	.836	.054	6.5
Jan. 1	.500	.028	5.6	.521	.012	2.3
2	.771	.031	4.0	.855	.083	9.7
3	.792	.030	3.8	.960	.087	9.1
4	.459	.036	7.8	1.857	.110	5.9
5	.521	.023	4.4	.542	.058	10.7
Average	.585	.033	5.7	.878	.068	7.7

Mr. Jackson, in his report, draws his conclusions from the results of three tests made in five-gallon bottles, from Jan. 2 to 19, 1920. In all, 98 liters of sewage were added to the first bottle (Bottle 5), 63 to the second and third (Bottles 6 and 7). The remarks under "Nitrogen Fixation" are;

1. Bottle 5, New York City sewage. Gain in NH_3 during experiment, 42.7 per cent.

2. Bottle 6, New York City sewage and activated sludge from Mt. Vernon. Gain in NH_3 during experiment, 25.1 per cent.

3. New York City sewage, activated sludge from Mt. Vernon and iron. Gain in NH_3 during experiment, 2.9 per cent.

Nitrogen fixation was claimed on the basis of the first two tests, *in which no iron was added.* In Test 3, when iron was added, practically no fixation was indicated.

It is difficult to see how a nitrogen balance was calculated for these tests as the analyses in the report show only results for free ammonia and *albuminoid ammonia*, not total organic nitrogen.

A clear distinction must be drawn between true fixation of atmospheric nitrogen and coagulation or adsorption of soluble ammonia nitrogen on the surfaces of insoluble particles of activated sludge. In the first case the total nitrogen of the complete system must be increased; in the second case, the total nitrogen of the complete system does not increase, in fact, it usually decreases, but a small amount of soluble ammonia is removable in an insoluble form. While most investigators of the activated-sludge process admit that the latter occurs, there are very few who believe as yet that the fixation of atmospheric nitrogen by the activated-sludge process has been demonstrated.

The most painstaking work that has so far been done on this problem has been reported by E. H. Richards and G. C. Sawyer (Jour. Soc. Chem. Ind., 41, 62-72, March 15, 1922) who describe many experiments made at Harpenden, at the Rothamsted Experiment Station, on the microbiology of activated sludge, and on the nitrogen relations of sewage and activated sludge, with particular reference to nitrogen fixation. All tests showed a loss of nitrogen, in some cases as high as 30 to 40 per cent. Among other conclusions the authors state:

"In all our experiments, both at the sewage-works and in the laboratory, there is no evidence of any fixation of atmospheric nitrogen. The amount of nitrogen recovered in the sludge is always less than the amount removed from the sewage during treatment. This does not, of course, prove that no fixation of atmospheric nitrogen occurs, but the amount fixed must be less than that lost as the result of the partial aerobic fermentation of the sewage."

On the basis of the data which Mr. Peck has outlined in brief, the Dorr Company definitely abandoned the Dorr-Peck process by the announcement made in your journal on Feb. 9, 1922, p. 251. Out of four trials—at Mt. Vernon, Argo, Urbana and Decatur—three had proven negative and the fourth and original was open to doubt even in the minds of the company financing the tests. It is our understanding that the Dorr-Peck process as originally put forward involved the claim of nitrogen fixation.

We have outlined our criticism at some length because we feel that the fundamental facts concerning the activated-sludge process should be developed with great care, taking due account of the variable conditions met with in different sewages. Facts can be established only by tests extending over periods of months with all operating and analytical data under rigorous control.

F. W. MOHLMAN, Chief Chemist.
LANGDON PEARSE, Sanitary Engineer,
Sanitary District of Chicago.

March 28.

Sir—Replying to the criticism by Messrs. Mohlman and Pearse of my paper on "The Fixation of Atmospheric Nitrogen in the Activated-Sludge Process:" I asserted that in certain tests at Mt. Vernon and at Columbia University atmospheric nitrogen had been fixed in the presence of so-called activated sludge. My claim is limited to this statement. There is no claim that it can always be accomplished. It is not asserted that the proper environment for such a result is known. A list of failures is given.

As my critics say, before such a fundamental phenomenon can be accepted it must be established by clear and indubitable evidence. I am prepared to supply the details of this evidence to any engineer, society or scientific journal desiring to examine it. I cannot here enter into a thorough discussion of this evidence, but the following discussion will, I believe, dispose of the objections of my friends Messrs. Pearse and Mohlman and raise the presumption of probable truth of my statements in the minds of those who read it.

TABLE I—AMMONIA CONTENT OF SEVERAL CONSTITUENTS OF THE SLUDGE

	Per Cent NH_3
B Vortiella	16.95
B Crenothrix	8.00
Fibre and paper pulp	1.26

Messrs. Pearse and Mohlman draw their assumptions from a tabulation of two tank tests at Mt. Vernon and the report of Dr. Jackson on the Mt. Vernon and Columbia University tests. They assert that the data submitted to them do not warrant my conclusions. They assign the following reasons:

1. That the tabulations indicate that during the period of the tests the tanks were "unloading" and that this would upset any reasoning on the phenomena occurring.

2. That excessive variation from day to day in the reported sludge analyses indicates lack of caution in checking analyses and casts doubt on the accuracy of the results.

3. That the duration of the tests was too short to warrant any conclusions.

4. That nitrogen determinations appear to have been made up from "free ammonia" and "albuminoid ammonia" instead of from "total organic nitrogen" determinations. That results so obtained are no evidence of the total amount of nitrogen in the complete system, and therefore no evidence of fixation.

Now these are errors, every one. But before discussing them I would state that had I no more evidence than that cited by my critics I would not have laid the results and my conclusions before your readers.

As to the first objection, that the tanks were unloading nitrogen which I mistook for fixed atmospheric nitrogen: At the start and at the finish of each of the tank tests the amount of nitrogen and of solids in the tanks was carefully determined. It was found that the tanks *had* unloaded. The amount so unloaded was deducted from the excess of nitrogen and solids discharged and the balance, still in excess of the nitrogen introduced with the sewage, could have come from but one source, the atmosphere. In one case this increment in excess of nitrogen fed in with the sewage and unloaded by the tanks was approximately 15 per cent, in the other 5 per cent.

As to the second objection, unreliability of tests as shown by wide variations in daily solid nitrogen percentages: I agree with my critics that wide variation in nitrogen content of solids in sludge is evidence of careless work in sampling or determinations or both and such results cannot be trusted. I deny that the tabulations indicate any such variation. In Table II I have set down the daily analyses

TABLE II—SLUDGE ANALYSES UNDER CONDITIONS STATED

Showing consistent analysis of dried sludge and concurrent analyses of samples of same sludge taken at dilutions ranging from 125 to 446 p.p.m.; also relative ammonia content of wet unacidulated sludge and sludge which had been acidulated, drained and dried before analysis

Date 1919	Per Cent NH_3 in Dried Sludge	Calculations by Messrs. Pearse & Mohlman: Per Cent NH_3 in Suspended Solids	Calculations by Messrs. Pearse & Mohlman: Tons Suspended Solids per Million Gallons
Dec. 29	9.03	9.9	0.894
Dec. 30	8.90	9.9	0.562
Dec. 31	8.17	6.5	0.836
Jan. 1	7.83	2.3	0.521
Jan. 2	8.64	9.7	0.855
Jan. 3	8.94	9.1	0.960
Jan. 4	8.90	5.9	1.857
Jan. 5	8.34	10.7	0.542
Average	8.60	7.7	0.878

on dried sludge alongside the calculations of nitrogen in suspended solids and the amount of suspended solids as prepared for me by Dr. Mohlman. Below this tabulation is shown the effect of our method of determining ammonia in the dried sludge in concentrating the ammonia. Explanation: Our determinations of soluble and insoluble ammonia and suspended solids were made on *tank effluent*. During the period of the tests under discussion no settled sludge was drawn from the tanks, excess was permitted to overflow with the finished liquor through a recording meter and samples were taken hourly at the meter discharge. During the period of the test under discussion these solids ranged from 125 to 450 p.p.m. Samples of settled sludge were taken daily. These were treated with ½ c.c. of sulphuric acid per litre, drained through cheesecloth, dried and analysis made of the *dried* sludge. This treatment resulted in the solution of the alkaline constituents of the sludge and consequent concentration of the ammonia. The extent of this is indicated in the bottom line of the tabulation. *Now if* we apply the degree of concentration shown to attend the method of dry sludge analyses to the averages of acid-treated sludge analyses and compare with Dr. Mohlman's calculation, 8.60 per cent sludge would be derived from 7.5 per cent suspended solids. The calculation shows an average of 7.7 per cent. Sludge samples are taken in concentrations ranging from, say, 3,000 to 30,000 p.p.m. of suspended solids. They constitute a fair average of all the solids, and their analysis will result in a fair average of the ammonia content. Where the solids are sizable and of widely varying N content, and the samples are taken in dilutions of from 125 to 450 p.p.m. there will be considerable variation in analytical results. The solids in No. 2 tank effluent used by my critics in their illustration were of an unusual character. Only 0.05 cu.ft. of air per gallon per hour was used. Agitation was very gentle. The average period of sludge detention in the tank was perhaps weeks. Biological aggregates of considerable size developed. When dilute sludge from this tank was permitted to stand in an Imhoff cone these masses, white as snow and mostly composed of vorticella, settled to the bottom of the cone and formed a zone of their own. The wide difference in the ammonia content of different classes of suspended solids contained in the materials analyzed is shown in Table I.

As to the third objection, that the period of the tank tests was too short to prove anything: If they stand alone, as my critics seem to infer, they are. I think they must be included in additional evidence rather than in the category of proof. *If* influent and effluent samples and analyses were

TABLE III—RESULTS OF FIFTEEN MT. VERNON NITROGEN FIXATION BOTTLE TESTS

Group 1. Showing fixation of atmospheric nitrogen in the presence of Crenothrix sludge.

		Per Cent
Bottle No. II	Gain in total nitrogen	62.5
V	Gain in total nitrogen	65.9
VI.	Gain in total nitrogen	31.2
XIII.	Gain in totalnitrogen	21.3
XVIII.	Gain in total nitrogen	65.9
Group 2.	Dosed with iron salts which proved inimical to Crenothrix.	
Bottle No. VII.	Gain in total nitrogen	1.0
VIII.	Loss in total nitrogen	0.8
IX.	Gain in total nitrogen	3.5
XVI	Gain in total nitrogen	0.5
XV.	Gain in total nitrogen	2.8
Group 3.	Not dosed with iron. No growing Crenothrix observed in the sludge.	
Bottle No. I	Loss in total nitrogen	17.4
III	Loss in total nitrogen	21.6
IV	Loss in total nitrogen	18.3
XIV	Loss in total nitrogen	30.8
XV	Loss in total nitrogen	34.5

accurate, and *if* stock of ammonia in the tanks at the start and finish of the tests were accurately determined, then a single day would prove whether or not ammonia was fixed. None of these conditions can in practice be met. I am sorry the tests were not of greater duration. One was terminated by poisoning the sludge. The other by "flu" in the staff. I hold them to be corroborative only of the bottle tests conducted at Mt. Vernon and at Dr. Jackson's laboratories at Columbia University.

A summary of fifteen of the Mt. Vernon bottle tests is given in Table III. Analytical data on these tests are not subject to the criticisms and possibilities of error which are inevitable in commercial tests. The sewage used in the bottle tests was prepared by filtering it through cheese cloth. This made accurate sampling possible. All samples not tested immediately were preserved with an excess of chloroform, in cold storage. All samples and bottles were kept in a building separate from the laboratory. Charging, sampling, analyzing were performed by competent chemists of several years experience in organic analysis. All chemicals and reagents were tested for purity; separate beakers, pipettes, etc., were used for handling and sampling the several liquors and sludges. Accuracy was checked by the usual means. In short everything was done which our own

staff or Dr. Jackson, consultant, could suggest to secure accuracy and reliability.

As to the fourth objection: The reported total ammonias in these tests are all Kjeldahl-Gunning determinations.

I feel that no engineer in possession of all the facts would hesitate to subscribe to my conclusion that "under certain conditions it is possible to fix atmospheric nitrogen in the presence of activated sludge." C. LEE PECK.

New York City, April 21.

How Can We Stop Duplication of Orders?

Following the publication of the editorial "How Can We Stop Duplication of Orders?" in its issue of April 26, p. 735, Engineering News-Record called upon a number of leading contractors and dealers for an expression of their opinion on the subject. The replies received to date follow:

Sir—Have read your editorial with much interest. I agree with your views absolutely. If your suggestion could be made a general practice I believe it would have a very stabilizing effect on the whole industry.

New York, May 4. FRED T. LEY,
President, Fred T. Ley & Co., Inc.

Sir—I have carefully read the editorial in *Engineering News-Record* of April 26 entitled, "How Can We Stop Duplication of Orders," and wish to say that I am in thorough accord with it. I know from personal knowledge that there are a tremendous number of duplicated orders at this time. There are only two ways to prevent this: (1) For dealers, non-cancellable orders; (2) for contractors, what are known as job orders, by which material ordered by the contractor can only go to one job, and only a sufficient amount of material can be ordered by a contractor to do that particular job. I think this would, in a large measure, stop duplication of orders. It would still, however, be possible for a contractor to order material for a certain job from two manufacturers, but I am of the opinion that very few would, as it would be discovered as soon as the job was started.

New York, May 4. D. A. GARBER,
President, North-Eastern Construction Co.

Sir—I fully agree with the sentiments expressed in the editorial. I believe that not alone good economics but also good morals demand that the reprehensible practice of placing contracts which there is no intention of carrying out be stopped. It will be a sad day in our country when contracts come to be looked upon as "a scrap of paper" by a substantial part of our business community.

New York, May 4. L. J. HOROWITZ,
President, Thompson-Starrett Co.

Sir—I think you are quite right in the principle of over-ordering, and while it is an evil that I should very much like to see stopped, I doubt if it is as much of a practice with contractors in general as it is with many others who are near-contractors, such as the larger manufacturing companies like the various steel corporations which usually do their own work, a great many of the railroads which buy direct, and some of the highway departments. I understand from a very reliable source that the State of Maryland has work that will take actually about 750,000 bbl. of cement this year if the entire amount of work is done; they have actually bought against this 1,500,000 bbl. The old adage, "Every Jack for his own trade," is true in the construction business. States, municipalities, corporations and others, no more fitted to do construction work than my company is to do publication work, are attempting to carry on and the practice is growing with alarming rapidity. It is their belief that they are going to save money, but they are only fooling themselves because they do not keep accurate costs and records, do not charge in the proper overhead, nor do they ever reckon up to see whether the job comes within any reasonable estimate.

My experience is that work done outside of the regular contracting field, where the contractor either has to do the job for his limited cost by contract or go broke, is done largely on the principle of necessity. In these cases the owner pays the freight. There is no contractor to blame, but conditions compare with some of the worst instances claimed against the cost-plus-percentage system. Naturally, under such conditions, we are going to have a great many evil practices grow up that are a detriment to the construction industry as a whole and to the ultimate consumer.

With regard to the contract for materials which you speak of, this form is most prevalent in the cement and steel industries. In most other lines, such as brick, broken stone, sand and gravel, material is bought at a fixed price for the job and while probably no definite quantity is agreed upon, it is intended that all required on the particular project shall be furnished at that price and, of course, the orders are subject to cancellation if cancelled before delivery. I thoroughly agree with all you say about this particular form of alleged contract and I have worn myself out discussing this point with the cement manufacturers who, I believe, are entirely to blame for it.

I have tried for years to buy at the first of the year a year's supply on a definite number of barrels of cement at a definite price with no ups or downs and an agreement to take, within the year, the actual number of barrels specified. Invariably I have had the reply that they could not sell it to me on that basis unless I could tell them the particular projects on which I wished to use the material, that they would much prefer to sell me my requirements from job to job and that it would be unfair to me not to give me the benefit of any drops in the market and at the same time guarantee a maximum price.

I think you are working on a line that is well worth while and something we have often discussed in our A. G. C. councils. If you can arrive at a solution of the problem and get it adopted you will have been of great help to the industry, but in order to do so I believe your greatest amount of work will have to be done with the manufacturers who brought the evil upon themselves rather than the contractors, but I do not mean by this that the contractors are entirely blameless.

Buffalo, May 3. J. W. COWPER,
President, The John W. Cowper Co., Contractors,
Buffalo, N. Y

Sir—I have read with much interest the editorial which appeared in *Engineering News-Record* of April 26 on the subject of the duplication of orders for materials. Of course, my observation is based very largely upon the operations of my own company and I can tell you that it has not been the practice of our purchasing department to duplicate orders, but to place the orders with companies of dependable standing, companies where our experience has led us to believe that the service would be rendered as nearly as conditions would permit.

I have had some experience with a large steel-bar company selling to contractors and it was not the practice there to duplicate orders, although in some cases they may have purchased steel in anticipation of rising markets and have taken the steel to their yards for distribution. The conditions complained of have existed, I believe, among material dealers and I know the cement companies have had a great deal of difficulty in appraising the value of orders placed with them by dealers.

The problem, it seems to me, is in the direction of educating business men as to the sanctity of contracts; if business morals can be improved, this problem will be likewise improved. H. C. TURNER.
President, Turner Construction Co.

New York, May 7.

More Power on the Susquehanna

The Susquehanna Power Co. has filed application with the Federal Power Commission for a preliminary permit for a power project on the Susquehanna River between tidewater and Conowingo, Md., downstream from the Holtwood power plant at McCall Ferry, to develop 260,000 hp.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

News Brevities

A New Bureau of Housing is to be established in the New York State Department of Architecture according to a bill passed by the legislature. The bureau is to supervise housing and regional planning, and will be in charge of an assistant state architect.

A New Transatlantic Cable is to be laid between New York and London in the immediate future by the Postal Telegraph-Commercial Cables System. The new cable will average 1,100 lb. of copper per mile, 400 lb. more than the largest existing cable, and will have a capacity of 600 words a minute in each direction.

Except For Some Double-Track work now under consideration, improvements for this year on the Nashville, Chattanooga & St. Louis Ry. are mainly of a miscellaneous character. The outstanding authorities for improvements already contracted for amount to $603,180 for roadway and $2,637,639 for equipment.

The Lehigh Valley R.R. Has Opened the first unit of its new Claremont Terminal on the New Jersey side of New York harbor (*Engineering News Record*, May 13, 1920, p. 970). The completed portion of the pier is two-thirds of a mile long and 400 ft. wide. It is provided with a gantry dock, a freight shed dock, and an ore dock, as well as a freight yard of 2,700-car capacity.

Bismarck, N. D., Will Vote May 14 on the question of the issuance of bonds for construction of a complete municipal waterworks system. Plans made by T. R. Atkinson, city engineer, contemplate reservoirs, filtration and softening plants, pumping station and distribution system, to cost $704,000. L. P. Wolff, of St. Paul, is consulting engineer for the project.

Construction Work on the Esquimalt drydock (*Engineering News-Record*, April 21, 1921, p. 670) has been postponed for about two months by the flooding of the entire dock excavation due to a break in the outer cofferdam early in January. The Pacific Construction Co., which has the contract for the repair work, is driving wooden piles to replace the 300 ft. of sheet piling carried away in the break.

Improvements Planned by the Great Northern Ry. for 1923 include 35 miles of double tracking; new engine terminals at St. Cloud, Fargo and Watertown; 345 miles of automatic block signaling; extending 34 passing tracks; completing the new steel ore dock No. 2 at Allouez, Wis. (to be in operation in May); and rebuilding timber ore dock No. 1 at Allouez.

Canada Votes $50,000 to Study Second Chippawa Power Project

On April 30 the Ontario Legislature appropriated $12,687,000 for the Provincial hydro-electric power system, distributed among the different developments as follows: Niagara system, $9,850,000; Muskoka, $360,000; Rideau, $20,000; Thunder Bay, $1,015,000; Central, $1,375,000; Nipissing, $17,000; and Essex, $50,000.

The sum of $50,000 was also voted for an investigation by the engineers of the hydro-electric system on a second Queenston-Chippawa development, looking to the possibility of another canal. Hon. Dougall Carmichael in asking for the appropriation stated that if present facilities were used to capacity the commission estimated that it could only supply the demand until 1926 or 1927. The total amount involved in the capital expenditure on the Queenston-Chippawa development up to October 21, 1922, was $65,495,248. In February last there was sold from the four units at Chippawa now in operation 180,584 hp. The total output of all the plants at Niagara is approximately 510,000 hp. After deducting operating expenses and maintenance charges there was left a little over $1,000,000 of a surplus from the sale of power from the Chippawa units for the four months ending February, to apply to the reduction of interest charges.

Delaware Gets Funds for Two-Year Road Program

As a result of action by the Legislature of Delaware the State Highway Department is authorized to undertake, during 1923, a road program involving $2,500,000 and a similar amount for the year 1924. It is planned to complete 175 miles of hard-surface road during the next two years.

The increased funds, according to information received from the State Highway Department, are derived from a 1-c. per gallon motor-vehicle fuel tax which went into effect Apr. 22. This tax will be increased to 2c. a gallon beginning in 1924.

Trenton Sewage-Works Plans Acted on by State Health Board

The State Board of Health of New Jersey refused on May 1 to approve Col. George A. Johnson's plans for treating the sewage of Trenton by the direct-oxidation process but gave the city a month's time to submit the plans for reconsideration as an experimental plant. The board stated that a less expensive plant, both as to first cost and maintenance, would meet the local needs and expressed the opinion that for ten years probably or considerably longer sedimentation alone would suffice or in lieu thereof fine screens, followed by lime precipitation in a tank equipped by a thickener.

Harding to Ask Special Report on Mississippi

New Orleans Engineers Seek Aid of President in Support of Spillway Project

Washington Correspondence

President Harding has promised to call upon the Mississippi River Commission for a special report in connection with the spillway project proposed by the city engineer of New Orleans. The President gave more than an hour of his time recently to a delegation from New Orleans that appealed to him for assistance in securing additional measures looking to flood relief. He evinced a keen personal interest in the situation and promised to help in any way within his power. He stated that he sees no reason why the Federal Government should not take counsel in a matter of this kind with such men as John R. Freeman, C. E. Grunsky or D. W. Mead.

The New Orleans delegation told the President that the Mississippi River Commission apparently is wedded to the theory that levees constitute the only method of handling flood waters on the lower Mississippi. John Klorer, the city engineer of New Orleans, supported by James P. Kemper, and W. B. Gregory, other civil engineers of New Orleans, have drawn up plans for a spillway intended to discharge waters from the flood plain of the Mississippi into Lake Borgne, an arm of the Gulf of Mexico. They contend that such an expedient will lower flood heights in the Mississippi at New Orleans and will provide a safe means for discharging 220,000 sec.-ft. of water, when the river is in flood.

The New Orleans engineers told the President that the Mississippi River Commission not only is opposed to the project but declines to give it sympathetic consideration. The New Orleans engineers filed with the President specific statements with regard to the engineering phases of the spillway. The President promised to submit these claims to the Mississippi River Commission for reply. With the contention of each party to the controversy thus outlined, it is anticipated that the President will seek the advice of distinguished engineers as to the respective merits of the two positions.

Southeastern Water and Light Association Formed

At the recent annual convention of the Tri-State Water and Light Association covering North and South Carolina and Georgia, it was voted to extend the territory of the association to include Alabama, Florida, Tennessee and Mississippi and to change the name to the Southeastern Water and Light Association. J. E. Gibson, manager and engineer of the water-works of Charleston, S. C., was re-elected as president, and W. F. Stieglitz, of Columbia, S. C., was re-elected secretary and treasurer.

W. L. Benham President of A. A. E.

New Head of American Association Is Consulting Engineer of Kansas City and Oklahoma City

Webster L. Benham elected president of the American Association of Engineers when the official ballot was canvassed last week and who was installed at the association's convention being held this week in Norfolk, is owner and chief engineer of the Benham Engineering Co. of Kansas City and Oklahoma City, consulting engineers engaged in general municipal and industrial engineering work. He is an active member of various technical societies and has served the Association both in committee work and as national director.

Mr. Benham is a graduate of Columbia University, from which institution he received a C. E. degree in 1905. After graduation he was first employed by Columbia University in building work, and later by the New Jersey Zinc Co. Thereafter he became a member of the firm of Benham & Adams, engaging in general engineering including townsite surveys, paving plans and design of sewage and sewerage systems, waterworks and reinforced-concrete structures. In 1907 he was appointed assistant city engineer of Oklahoma City, a position he held until 1909 when he entered consulting practice. He engaged in private work almost exclusively until 1916 when he was made city engineer of Blackwell, Oklahoma. After the war he formed an association with Lieut.-Col. George A. Johnson under the firm name of Johnson & Benham, with offices in Kansas City.

He is a member of the following societies beside the American Association of Engineers:

American Society of Civil Engineers, American Society of Mechanical Engineers, American Society for Municipal Improvements, American Water Works Association, and the Oklahoma Society of Engineers. His work in the Association includes the chairmanship of the Committee on Services and Fees of Practising Engineers and membership on the Committee on National Department of Public Works.

A.G.C. Directs Chapter Programs

As a means of co-ordinating the efforts of the Associated General Contractors with those of its local chapters, the national organization is sending to the chapters topics for discussion at the monthly meetings and at the same time is inviting suggestions regarding topics of interest. By this method it is believed that the association may be brought more intimately into touch with the thought of its chapter membership. The executive board of the A. G. C. approved the plan, which was inaugurated at the Los Angeles convention. The first topic selected was overhead expense, subdivided into means of estimating and means of reducing it.

N. Y. License Law Not Operative Until August 1

By the terms of a bill signed by Governor Smith May 4 the last date upon which applications for engineers' licenses may be filed in New York State has been extended from May 5 until August 1, this year. That is to say the time in which practising within the state is possible without a license has been extended three months. After August 1 those engineers not having previously applied for licenses will subject themselves to penalties if they continue to practice. Examinations for licenses are not compulsory but the registration board is empowered to require examinations where it deems them necessary. Contrary to a previously published statement therefore, the matter of examinations, where and when they may be demanded is a discretionary power of the board. Passage of the bill which has extended the time for registration was largely due to the activities of the mining and mechanical engineers.

City Planning Conference at Baltimore Well Attended

The City Planning Conference at Baltimore, Md., April 30 to May 2, was largely attended. There was a full program of papers, as outlined elsewhere in this issue. George B. Ford, of the Technical Advisory Corporation, New York City, was elected president for 1923-4, and John Nolen, Cambridge, Mass., vice-president. Flavell Shurtleff, 130 East 22nd St., New York City, was re-elected secretary. A resolution was adopted advocating state legislation to authorize county authorities to provide for county-wide planning and for inter-county co-operation in planning.

Hetch-Hetchy Mountain Division Tunnels Near Completion

With an alignment discrepancy of only a few inches the 4-mi. section of the San Francisco Hetch-Hetchy water supply tunnel between Priest Portal and Second Garrote shaft was holed through on April 25, 19,847 ft. from Priest Portal and 640 ft. from the bottom of Second Garrote shaft. This leaves only slightly more than a mile yet to be driven before the tunnel will be continuous for the 18 miles from Early Intake to the forebay at Priest Portal, whence the Moccasin Creek power house will draw its supply. Of this mile all but a few hundred feet are in the section between the headings now being driven east from Second Garrote shaft and west from Big Creek shaft. The two other short sections yet to be holed through, lying between Camps 5-6 and Camps 8-9 and between Early Intake and South Fork, will be completed in May.

Of the placing of concrete lining, working from Big Creek shaft, about 2,100 lin.ft. was completed, except for invert, by April 25. With the specially devised concreting equipment used on this work it is expected to line 150 ft. of tunnel per day when the system is working at full efficiency.

New Orleans Opens Its New Inner Harbor and Industrial Canal

With a water pageant which reviewed in a realistic way the 112 years of river navigation on the Mississippi, the Port Commission of New Orleans on May 5 formally opened its $20,000,000 inner harbor and industrial canal. The development is the result of a desire on the part of New Orleans to provide industrial basin and ocean docks free from the impediment imposed upon the port's facilities by the variable level of the Mississippi River. The entire project is developed along a 6-mi. canal, extending from the river to Lake Pontchartrain, which is provided with a lock at the river end to maintain the water in the canal at the level of the lake. The water level in the lake only varies about 6 ft., while the river has a flood variation of nearly 20 ft. The river approach to the lock is provided with continuous river levees 23 ft. above low water and a channel 125 ft. wide and 30 ft. deep. The lock is 30 ft. deep over the sills and has a usable length of 640 ft. and a width of 75 ft. To provide against the reverse pressures due to the variation in the level of the river and the lake the lock is equipped with gates mitering in either direction.

The canal will ultimately have a bottom width of 150 ft., a surface width of 330 ft., and a depth of 30 ft.

A portion of the canal will be provided with diagonally placed ocean slips 225 ft. wide and 650 ft. long. They will be built as fast as required and will serve in lieu of turning basin. The canal is crossed by bridges for booth railway and highway traffic, and by a large siphon for the city's main drainage outlet. The four bridges are all of the bascule type and the ones within the city proper are double decked to separate the vehicular and surface-car traffic from the railway traffic.

The canal has been described in the following issues of *Engineering News-Record*: Aug. 15, 1918 p. 304; May 13, 1920, p. 940; Apr. 22, 1920, p. 808; and Sept. 15, 1921, p. 437.

Rock Island Railroad to Spend $6,500,000

The program for additions and betterments on the Chicago, Rock Island & Pacific Ry. for the current year amounts to $6,530,000. Construction of a second main track between Herington and Latimer, Kan., and Paxico and Bishop, Kan., a total distance of 29 miles, is estimated to cost $1,500,000 and part of the work is under contract; this includes a small amount of relocation of line. There will be considerable construction and extension of passing tracks in order to expedite train movements, this work being estimated at about $400,000. A few branch lines are under consideration and some separation of grades in cities may be carried out if necessary. Grading is in progress for a new freight yard and terminal at Omaha.

No large new engine terminals are planned, but extensions and additions are being made to a number of roundhouses in order to accommodate new engines of larger size.

Flood Prevention Status in Pueblo

Engineers working on the flood prevention problem of Pueblo, Colo., have decided that the best method will provide for a new channel near the bluffs supplemented by a small retarding basin. The favorable decision on the validity of the Conservancy law Feb. 27 will expedite the work. Barton Jones, resident engineer, Dayton-Morgan Engineering Co., in the *Engineers Bulletin* of the Colorado Society of Engineers, gives the following information:

The present river channel has a capacity of 35,000 or 40,000 sec. ft. while the new channel (see *Engineering News-Record*, Sept. 28, 1922, p. 530) will have a capacity of 125,000 sec. ft. The peak flow during the 1921 flood was 90,000 sec. ft. The plan as a whole will therefore protect against a flood much larger than the last. The outflow at the Rock Canyon Barrier will be limited to 100,000 sec. ft., which would be reached only in case of a flood 82 per cent greater in intensity than the last, and 82 per cent greater in duration. An allowance is also provided in the capacity of the new channel for a coincident flood of 25,000 sec. ft. from Dry Creek, immediately above Pueblo.

The plan, as proposed, does not disturb the arrangements of the railroads other than the Denver & Rio Grande-Western, whose yards must be relocated north of the new channel.

The appraisers of the district, appointed by the Conservancy Court on Nov. 8, 1922, have been at work since then, employing from 15 to 20 men, and good progress has been made. Until a plan has been finally adopted, they must confine their work to such features as would not be changed by any likely modification in the plan. As soon after the adoption of the plan as possible, the appraisers will complete their work conforming to the plan, and file the appraisal roll. Published notices and a court hearing also precede the adoption of the appraisals.

Contracts for doing the work will not be let until the sale of the bonds has been arranged. The bonds can be sold when a sufficient part of the appraisal roll has been approved to insure a margin of security satisfactory to the purchasers. The procedure providing for notices, hearings and adoption of the plan, and appraisals, will require 3 to 4 months after a recommended plan is filed. Without any delays, the work could commence in June or July.

San Diego Constructing Pier No. 2

The city of San Diego has work well under way on a new pier north of Municipal Pier No. 1 to be known as Pier No. 2. The construction is sand fill with reinforced-concrete apron wharves on both sides and the outer end. The pier will be 1,000 ft. long and 400 ft. wide, and will have a 143 x 940-ft. transit shed.

On May 1 the fill had been brought up above low water to heights of 5 to 8 ft. for the entire length and width of the pier. A total of about 300,000 cu.yd. of dredging is involved and the cost of the entire project is to be $850,000.

Frank G. White, chief engineer, State Board of Harbor Commissioners, was retained to prepare complete plans and specifications and to supervise construction, and is assisted by H. E. Squire.

Milwaukee Has Large Public Works Program

City improvements planned for the current year at Milwaukee, Wis., under R. E. Stoelting, commissioner of public works, include the following items: Riverside pumping plant, contract let at approximately $1,500,000; storm sewers, $1,270,000; various local sewers, $125,000; State St. bridge, $400,000; widening Folsom St. bridge, $150,000. Bids for these bridges will soon be invited. The street paving program includes 130,000 sq.yd. of reinforced-concrete paving, 75,000 sq.yd. of vibrolithic and 50,000 sq.yd. of asphalt, besides considerable alley paving with concrete. Improvements in progress which are not under the Department of Public Works include the extensive program for the sewage disposal plant of the Milwaukee Sewerage Commission and the grade separation on the Chicago & Northwestern Ry. between Allis and West Allis.

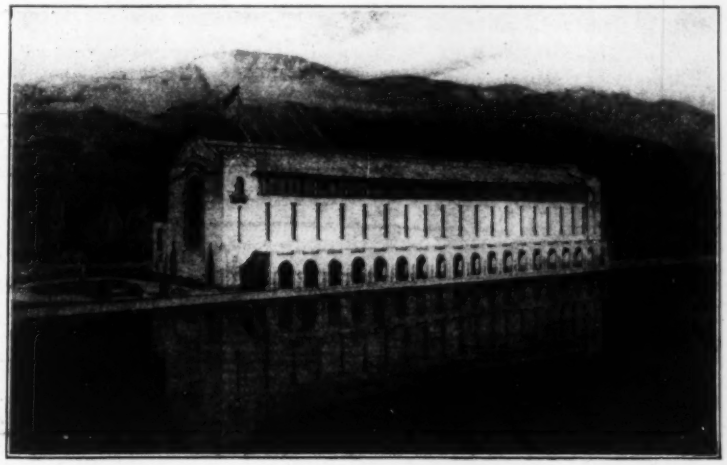
Aerial Maps of 220,000-Acre Tract Are Being Made

The Pioneer Aerial Engineering Co. of Beverly Hills, Calif., is preparing an aerial map covering 220,000 acres in the Volcano Lake district of Baja, California. The work is being performed under contract with the Government of Baja, California.

Approximately 1,000 photographs will be made from an altitude of 10,000 ft., thereby obtaining a scale of 1 in 10,000. The completed map will be 11 x 15 ft. in size.

The company claims that with the methods used a wealth of detail can be obtained more accurately than by ground surveying, and has guaranteed to produce a map of virgin territory previously unsurveyed in which the error will not exceed one-half of 1 per cent. The contract calls for delivery of the map within 90 days after completion of the aerial work.

Progress on Moccasin Creek Plant—Hetch Hetchy Project



CONSTRUCTION work is progressing rapidly at the site of the Moccasin Creek power house on the Hetch Hetchy project. Officials now estimate this plant will be in operation before the middle of 1924. On Mar. 2 1,680 ft. had been driven in the 5000-ft. tunnel from forebay reservoir to the top of the penstocks, and excavation for the four penstock lines was finished. Excavation for the power house is now under way, contract has been awarded for the structural steel frame of the power house and both electrical and hydraulic equipment for the power house has been under contract for some time; award of machinery contracts was noted in *Engineering News-Record* May 11, 1922 p. 803. All power house equipment is to be delivered before Aug. 31 of this year. An artist's conception of the power house as completed, is shown above.

The power house structure as now being built will be 225 x 70 ft. in plan with provision for the addition of 75 ft. in length to accommodate additional units to be installed later. Four generating units are going in under the present contract. These will include four 20,000 kva., 257 r.p.m., 3-phase 11,000-volt generators driven by double overhung impulse wheels rated at 25,000 hp. and operating under effective heads of 1,250 ft.

Where the penstocks enter the power house structure the flow will be controlled by eight 36-in. gate valves operated by hydraulic power. The power house equipment includes an overhead crane with a span of 50 ft. and a capacity of 135 tons.

The distance from the Moccasin Creek power house to the City of San Francisco is about 135 miles and survey crews are now in the field making final location for the double-circuit steel tower line which will be completed and ready for service before the power house is finished.

For the mountain and valley section of the transmission line a total of 525 miles of steel core aluminum cable has been ordered. This will have a cross-section of 389,000 circular mills, the equivalent of 250,000 copper circular mills. For the San Francisco Bay division of the transmission line an order has been placed for 177 miles of core copper conductor.

Transformers and switching equipment at the the new power house will be of the outdoor type. Thirteen 6,667 kw. single phase transformers will take the current at 11,000 volts, delta connected, and deliver it at 115,000 or 154,000 volts, star connected. Both oil and air break switches will be provided, designed to operate 154,000 volts, which will be the tension for which insulators and other transmission equipment will be provided.

Canadian Pacific Improvements to Cost $20,000,000

Capital expenditures of $7,630,100 for roadway improvements and $12,295,000 for equipment are planned for 1923 by the Canadian Pacific Ry. Some of the principal items of improvement are: Track material, ballasting and ditching, $1,250,400; rail renewals, $169,500; replacement and enlargement of structures in permanent form, $803,700; passenger and freight stations, shops and engine terminals, $318,400; sidetracks, $502,500; additional lining in the Connaught tunnel, $695,000; extension of Chateau Frontenac Hotel at Quebec, $2,800,000. In addition the construction or extension of three branch lines is proposed, funds for which will be raised by the sale of 4 per cent stock: Tuffnell and Prince Albert branch, 50 miles; Archive and Wymark branch, 25 miles; Kipp to Bow River, 22 miles. During 1922 the construction of branch lines amounted to $2,645,087 and improvements and betterments (exclusive of equipment) were carried out at a cost of $5,533,828.

French Society Celebrates 75th Anniversary

To celebrate the seventy-fifth anniversary of the founding of the Société des Ingenieurs Civils de France, the American section of that society held a joint meeting with the Four Founder Societies May 4 in the Engineering Societies Building, New York City. The meeting was addressed by Harrington Emerson, president of the American section of the society; Gaston Liébert, Col. Arthur S. Dwight, Gen. William Barclay Parsons and Charles O. Mailloux. A resolution was read from the Société in Paris. Henri Vigneron, a member of the French society, presented moving pictures of the mining of potassium in Alsace. Preceding the meeting, Mr. Emerson gave a dinner to some French and American engineers and members of the society.

American Marine Standards Committee Organized

At its meeting in New York April 17, with Captain R. D. Gatewood, U.S.N., as chairman, the general committee on standardization, recently formed by the American Marine Association for the establishment of standards for hull, engineering and operating details, adopted the name, American Marine Standards Committee, arranged a plan of organization, appointed administrative subcommittees and arranged for three technical sub-committees to carry on the project. A committee was appointed, consisting of E. H. Riggs, naval architect, New York Shipbuilding Corp., F. M. Hudson, Department of Commerce, and H. P. Frear, naval architect, Bethlehem Shipbuilding Corp., to present an outline of the project at the annual meeting of the Atlantic Coast Shipbuilders' Association to be held May 14 in Philadelphia.

The purpose of the American Marine Standards Committee is in line with the movement inaugurated by Secretary Hoover of the Department of Commerce for standardizing products and simplifying practices in the industries in order to eliminate waste and reduce costs.

T. H. MacDonald Will Address Road Builders at Annual Meeting

Results of the extensive traffic surveys in New England and California, made under direction of the U. S. Bureau of Public Roads, will be announced for the first time by Thomas H. MacDonald, chief of the bureau, at the dinner following the annual meeting and election of officers of the American Road Builders' Association, to be held at the Automobile Club of America, New York City, May 15. The traffic surveys have been under way for some time and it is understood that Mr. MacDonald's discussion of their results will bring out a great deal of new data on one of the most important problems in the highway field. Another feature of the dinner, which is scheduled for 6 p.m., daylight saving time, will be an address on highway maintenance problems by Frank Page, chairman of the North Carolina State Highway Commission and nominee for president of the American Road Builders' Association.

The annual meeting and election of officers of the association will be held at 3 p.m. standard time. Any one interested in highway construction and maintenance is invited to attend the annual dinner. Reservations at $3 a plate may be made through E. L. Powers, secretary of the association, 37 West 39th St., New York City.

India Approves £18,000,000 Sum For Barrage Across Indus

Announcement has been made by the Bombay Council, according to *Commerce Reports*, that the Government of India will finance the Sukkur barrage and canals project, and plans have been sanctioned by the Secretary of State for India. The project consists of a masonry structure across the Indus River at a point three miles below the Landsdowne bridge at Sukkur, Sind, India, with a system of canals taking off above it on each side of the river. The barrage, will have the form of a double bridge. The downstream bridge, 4,725 ft. long, will provide a traffic roadway across the river. The upstream bridge, with the controlled or automatic gates, will be 4,925 ft. long, including the land towers. There will be 66 spans in the barrage, each with a clear opening of 60 ft., arranged so that the openings can be closed, when required, by iron gates 18½ ft. high, in order to insure maintaining in the water at the barrage a level of 194.5 ft. above mean sea level at Karachi which will give a reading of 10.5 ft. on the Sukkur gage. Sluices will be provided at each end of the barrage, a group of seven spans at the left bank and a group of five spans at the right bank. The barrage openings provide for a maximum flood of 1,500,000 sec.ft. passing Sukkur, and it will be kept open during the flood months and closed when necessary to keep the required level in the canals.

For irrigation uses, four canals will take off on the left bank, and three on the right; drainage lines of the right-bank system will eventually tail into Lake Munchhar and thence into the Indus. Anticipated cultivation in the thirtieth year of operation is 5,308,408 acres, more than doubling the present 2,035,636 acres. The total project will cost approximately £18,000,000.

Engineering Societies

Calendar

Annual Meetings

NATIONAL HIGHWAY TRAFFIC ASSOCIATION, New York; Annual Meeting, New York, May 19.

AMERICAN ROAD BUILDERS ASSOCIATION, New York; Annual Meeting, New York, May 15.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION; Annual Convention, Ithaca, N. Y., June 20-23.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, Detroit, Mich., May 21-25.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Annual Meeting, Atlantic City, N. J., June 25-29.

The Society of Engineers of Eastern New York has elected as its president James E. Hewes, vice-president, the Albany Southern R.R. Roy Clark, professor of civil engineering at Rensselaer Polytechnic Institute, was chosen vice-president.

The Engineers' Society of Pennsylvania has nominated the following officers for 1923-1924: president, Robert W. Moorehead, Harrisburg; first vice-president, R. L. Gillespie, Steelton; second vice-president, Charles Haydock. The votes will be canvassed May 15.

The Boston Society of Civil Engineers will have motion pictures on the "Manufacture of Genuine Wrought-Iron Pipe" as the feature of its meeting May 16.

The North Carolina Drainage Association in annual convention elected F. P. Latham of Belhaven as president. W. D. Alexander of Charlotte was selected vice-president, and B. M. Potter of New Bern secretary and treasurer. The association will meet next year in Belhaven.

Personal Notes

W. L. ABBOTT of Chicago has been chosen chairman of the committee to make a nation-wide coal storage survey in co-operation with the U. S. Coal Commission and the Department of Commerce, according to the announcement made by the Federated American Engineering Societies. The other members will be named soon.

LEWIS B. STILLWELL, consulting engineer, New York City, has announced removal of his offices from 143 Liberty St. to 90 West St.

A. S. ZINN has resigned from the engineering department of the Missouri Pacific R.R. and will soon open a consulting office in Los Angeles, Calif. Mr. Zinn was resident engineer of the central division, Panama Canal, from 1906 to 1913. He was then appointed acting division engineer to relieve Lt.-Col. D. D. Gaillard. The central division included the Culebra Cut, since named Gaillard Cut. In January, 1914

through the recommendation of General Goethals, Mr. Zinn was appointed consulting engineer for the republic of Panama, a position which he held until 1916, when he returned to the United States. During the war he was in construction work and after the war assistant engineer of the United States Railroad Administration as well as affiliated with the Missouri Pacific R.R.

C. J. POPELKA, city engineer of Two Rivers, Wisconsin, has resigned to accept a position as street superintendent of the city of Beloit.

FRANK J. HENRY, formerly of the firm of Manske & Henry, Wisconsin Rapids, Wisconsin, has resigned and will open an architectural and engineering office at Wisconsin Rapids.

WILLIAM J. ROBERTS, civil engineer, Tacoma, has opened offices in the Puget Sound Bank Building, where he will specialize in irrigation, waterpower, waterworks and flood-relief engineering. Mr. Roberts was state highway commissioner, 1911-13, and was chief engineer of the White, Stuck and Puyallup Rivers flood-control project.

R. T. JAMES, formerly resident engineer with the North Carolina Highway Commission, has resigned and is engaged in industrial railroad and municipal engineering, with office at 1213 Realty Building, Charlotte, N. C.

THE CANTON ENGINEERING CO., INC., general contractors of Boston, have changed the corporate name to REYNOLDS BROTHERS, INC. The offices of the company are located at 179 Summer St.

WOOLFENDEN, WOOD AND WEBER, consulting engineers, formerly located in the Ideal Building, Denver, Colo., have changed the firm name and location. The firm is now WOOD AND WEBER, Tramway Building, Denver, Mr. Woolfenden having retired and moved to Detroit.

EDWARD T. GRAY and FREDERICK W. CLAFLIN of Johnstown, Pa., have formed a partnership, Gray & Claflin, engineers. Mr. Gray was formerly chief civil service engineer with the Cambria branch of the Bethlehem Steel Co. Mr. Claflin was resident engineer on construction of the Quemahoning dam and later worked with Perrin & Marshall, consulting engineers, New York City.

CARLETON E. DAVIS has resigned his position as chief of the Bureau of Water, Philadelphia, Pa., to become manager of the Indianapolis Water Co., but the city council of Philadelphia has asked him, in a reslution citing the contemplated increase in the city's water supply and his knowledge of the city's needs, to reconsider his resignation. Mr. Davis has accomplished some of the most important construction work in the water-works field. A graduate of the Massachusetts Institute of Technology, he served as assistant engineer in water-works construction at Manchester, N. H., and New Bedford, Mass., and as resident engineer in connection with the Pequannock water system of Newark, N. J. In 1904 he was made engineer in charge of water-works, sewers and municipal engineering for the Isthmian Canal Commission at Panama, Colón, and other points in the Canal Zone. From 1905 to 1912 Mr. Davis was department engineer of the reservoir department of the New York Board of Water Supply's Catskill aqueduct work; the Ashokan Dam was one piece of construction put through during this period. Since 1912, as chief of the Bureau of Water at Philadelphia, he has had charge of maintenance, new works, extensions and improvements in that city, embracing also the assessments of revenues aggregating $5,500,000 a year. Mr. Davis is a past president of the New England Water Works Association.

GEORGE M. WELLS, member of the consulting engineering firm of George W. Goethals & Co. of New York City and, some years ago, resident engineer in the building department of the Panama Canal, is going into private practice at 150 Nassau St., New York City.

J. L. MAHER, assistant division engineer, Baltimore and Ohio R.R., Connellsville, Pa., has been promoted to assistant engineer, Pittsburgh Division, with headquarters at Pittsburgh, Pa.

Hon. GEORGE P. GRAHAM, Canadian Minister of Defense, has resigned that position and has been appointed Minister of Railways and Canals. He has been Acting Minister of Railways for some months and was head of the Department of Railways in the Laurier government from 1907 until 1911.

C. R. CHADWICK, formerly with H. G. Balcom, consulting engineer of New York City, has entered the structural division of Stone & Webster, Inc., Boston, Mass., as engineer.

WESLEY H. BLANK, formerly instructor in bridge and building design at Massachusetts Institute of Technology, is now in the structural division of Stone & Webster, Inc., Boston, Mass.

E. B. POWELL, consulting engineer of Stone & Webster, Inc., returned from France on the S. S. "Paris" April 21. Owing to a severe illness he was confined to the American Hospital at Neuilly, France, for three months but is now much improved in health.

ALEXANDRE LARIVIERE, civil and electrical engineer of Quebec, has been appointed chief engineer of the Quebec Public Service Commission. Mr. Lariviere is a graduate of L'Ecole Polytechnique, University of Montreal, served as assistant engineer of the electrical department of the Montreal Harbor Commission, and later was bridge, maintenance and district engineer of the provincial road department. Since 1919, in a partnership with Edouard Hamel, he has been engaged as consulting engineer.

GLENN H. ALLEN, formerly a detailer for the American Bridge Co., has accepted a position in the same capacity with the International Steel and Iron Co. at Evansville, Indiana.

WILLIAM V. BENNETT, for eighteen years associated with H. B. Spraul, contractor of Scranton, Pa., is president of a newly organized construction company of Binghampton, N. Y. This company is known as the Parlor City Construction Co. and maintains offices at 10 Exchange St., Binghampton.

EDMUND I. MITCHELL, recently with the New York City Board of Water Supply, has taken a position with Waldo S. Coulter, consulting engineer, New York.

C. M. MILLER, formerly county highway engineer for Wake County, N. C., has been appointed county highway engineer of Forsythe County, with offices at Winston-Salem, N. C.

H. V. JOSLIN, engineer assistant to the chairman of the North Carolina State Highway Commission, has been appointed purchasing agent for the commission. Mr. Joslin's place has been filled by L. R. AMES, assistant to the state highway engineer.

T. H. MCKIBBEN has been appointed division engineer of the Chicago Division of the Atchison, Topeka and Santa Fe Ry., with headquarters at Chillicothe, Mo. Mr. McKibben has been chief project engineer for the same road for several years.

HARVEY MITCHELL ANTHONY, of Muncie, Ind., has been elected chairman of the state board of registration for professional engineers and land surveyors. He succeeds Prof. Robert L. McCormick of Terre Haute, Ind. Clyde A. Walb of Lagrange, Ind., was elected vice-chairman of the board.

FRED C. DOOLITTLE, state highway maintenance engineer at Colfax, Wash., has been transferred from the Walla Walla to the Spokane district and will be located at Davenport. He will be in charge of work west of Spokane, under Guy G. Harvey, district highway engineer.

RICHARD L. SAUNDERS, deputy highway commissioner of Connecticut, is to become chief engineer for the Amiesite Asphalt Co. of Philadelphia. During parts of 1912 and 1913 Mr. Saunders was assistant city engineer of Bridgeport, Conn., and previous to that he was an engineer for the New York City Board of Water Supply and worked on the Catskill aqueduct.

E. J. STEINBERG, for the past ten years resident engineer of the Wisconsin railroad rate commission, will resign June 1 to become manager of the Wausau properties of the Wisconsin Valley Power Co.

Obituary

GEORGE H. ANGELL, civil engineer in Denver, Colo., since 1860, died recently in that city, aged 65 years. His work was connected with the Denver & Rio Grande R.R., the Colorado & Southern R.R., and the city engineer's office in Denver. He was a native of Michigan.

WILLIAM H. GOLL, contractor, died in Philadelphia, April 27, at the age of 52. During his business career in Philadelphia, Mr. Goll did a great deal of construction work for the Pennsylvania, Reading and D. L. & W. railroads, which included remodeling the Broad Street station, erection of the West Philadelphia station and the elevated structure crossing at 31st and Market Streets.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Urge Early Release of Orders to Relieve Railway Jam

In anticipation of a shortage of railway transportation facilities later in the season, the Truscon Steel Co., Youngstown, Ohio, following recommendations made at the recent meeting in New York of the American Railway Association, is urging its customers to release all orders possible for early shipment. From the company's letter, dated May 1, and headed "A Word of Caution to Our Customers," the following is quoted:

"We are only a few days away from the time when the building season will be at its height, when everyone will want his material shipped "Immediately—Rush." Our stocks are in excellent shape to take care of any demand made upon us *now;* our shops are working efficiently; we can give real service *now.*

"But there are factors outside of our organization that affect our ability to ship promptly, and over these factors we have no control. We have for some time been experiencing difficulty in obtaining cars. This condition will get worse as the summer and fall approach, until we will be actually delayed in getting fabricated products away from and raw materials into our plant.

"In a formal statement following its recent meeting the American Railway Association urged every consumer and producer to anticipate the time when fruit, grain and coal movements will produce the annual peak load on the carriers and to ship everything possible in the early months of the year.

"We urge everyone to release their orders well in advance of the time when material will actually be needed on the job. Do not figure that the minimum time for shop fabrication plus the minimum time for transit from Youngstown constitutes sufficient time for notice of shipment, because the time will soon be here when that formula will not hold."

Commerce Dept. to Report Special Study of Labor

A report on the efficiency of labor and efficiency in handling labor will be issued soon by the Department of Commerce, Secretary Hoover having caused a special study of these related subjects to be made for some months. The report, it is said, will show that an "astounding" progress has been made in the United States in the last ten years. Labor turnover has been reduced materially by improvement of management, the report will show, while the efficiency of labor also has improved.

In view of the attitude of the Administration against material relaxation of the immigration laws the forthcoming report is considered of especial importance. In the opinion of Secretary Hoover industry must look to increased efficiency, not only of labor but of handling labor, to solve its labor problems.

To Confer on Reduction of Face Brick Varieties

A preliminary conference of manufacturers, distributors and consumers of face brick will be held May 11 with the Division of Simplified Practices of the Department of Commerce, Washington, D. C. The conference will discuss the advisability and practicability of reducing the number of types and sizes.

Limiting Factors in Record Runs of Equipment

Discussion of unusual performances stresses influence of co-ordinating all operations and need for considering "slowest link" in series of operations.

By L. B. Tuckerman
Engineer Physicist,
Bureau of Standards, Washington, D. C.

In THE recent discussion of "Record Runs of Equipment" in your columns one important point does not seem to have been definitely stated, although it is clearly implied in the editorial discussion in your issue of April 19, p. 694. Every piece of equipment acts as one member of a series of pieces and a record run implies a record co-ordination of all the members of the series. In every such series there is always a limiting factor, a slowest link, in the speed, which may be either the limiting speed of one member or a limit in the possible co-ordination of two members of the series. The possibility of economically speeding up this process of construction depends upon a knowledge of these limiting factors. An essential part of this is the knowledge of a "record speed" of each member of the series.

Such a record speed should not be the record of a mere spurt, which ignores all questions of overtaxing the equipment or of necessary shut-downs for repairs and adjustment. The record speed of this piece of equipment should be its maximum steady speed in a series of which it is the slowest link. In the case of your illustration of the concrete mixer on the highway contract it is important to the contractor to know how far it will pay him to provide for increased speed of supply of crushed stone, sand and cement, without danger of overloading the mixer. Data of genuine record runs—not mere spurts—of the concrete mixer are, therefore, of great value to him.

Where the slowest link comes in the co-ordination between two pieces of equipment, data of record runs need to be supplemented by full details of the elements involved in the co-ordination before they become valuable engineering data. Reliable information about record runs of equipment is always of engineering value, but a contractor who accepts such data without analysis is about on a par with a structural engineer who would consider that a satisfactory quality of steel was all that was needed to make a structure safe.

Penstock Valve Patent Valid, Court Rules

In a decision recently handed down by Judge Westenhaber in the U. S. District Court for Northern Ohio, Cleveland, the validity of the basic Johnson penstock valve patent was affirmed and the Wellman-Seaver-Morgan Co., of Cleveland, was found guilty of infringement in the suit brought by the William Cramp & Sons Ship & Engine Building Co., Philadelphia. The valve in question, the invention of R. D. Johnson and designed to control great volumes of water, is widely used in modern hydro-electric plants in this country and Canada. In view of the court's decision the Cramp company has announced that in future it will adopt a more aggressive attitude toward infringement of the Johnson valve patent.

The Cramp company, which handles the manufacture of hydro-electric equipment through its I. P. Morris department, acquired the commercial rights to the Johnson patent two years ago. At that time the valves were being marketed by the Larner-Johnson Valve & Engineering Co., Philadelphia, and previously they had been manufactured by the Wellman-Seaver-Morgan Co. under a royalty agreement with Mr. Johnson. Shortly thereafter the Wellman-Seaver-Morgan Co. placed on the market a valve in competition with the Johnson valve as manufactured by the Cramp company, which was claimed to be a distinct and original design. The Cramp company served notice of infringement and the suit just decided followed in due course.

The Johnson valve is designed for great sensitiveness and utilizes the principle that by decreasing the cross-sectional area of a conduit carrying water, thereby increasing the velocity of flow, the pressure in that region can be correspondingly diminished.

Construction Equipment Exported

Figures issued by the U. S. Department of Commerce show the following exports of construction machinery for the month of February, 1923: 50 concrete mixers valued at $33,953; 36 steam and power shovels at $150,454; 187 hoists and derricks (except mining) at $61,535; 95 centrifugal pumps at $12,168; 93 steam pumps at $30,795; 1,064 other power pumps at $134,548; and 641,579 lb. of other pumps and pumping machinery at $178,096.

Japan took the largest orders of concrete mixers, totaling $17,000. Honduras was the leader in the steam and power shovel field with two units at $46,000.

Bascule Spans Ordered for Bridges in U. S. and Abroad

The Strauss Bascule Bridge Co., Chicago, has been appointed to prepare plans and specifications for the bascule span of the Gandy Bridge to be built across Old Tampa Bay between Tampa and St. Petersburg, Fla. It will be a double-leaf underneath counterweight type affording a clear channel for navigation of 75 ft. in width and a roadway 24 ft. clear. Detail plans and specifications will be completed early this summer.

Recent foreign orders have been received by the Strauss company from

the Danish State Railways for the bascule span (30-meter channel) of a single-track bridge at Frederiksund across the Roskilde Fjord. A combined highway and railway bridge at Korsor, Denmark, will be equipped with a bascule span giving a 20-meter clear channel. The City of Stockholm, Sweden, has accepted a double-leaf bascule for the Skanstull bridge, the clear width of waterway being 17.4 meters.

Business Notes

OSCAR A. WHITE, since 1920 advertising manager of the Fate-Root-Heath Co., Plymouth, Ohio, manufacturer of gasoline locomotives, died April 22. He was 63 years of age and before his connection with the company had been prominent in newspaper work in the Middle West, having served from 1908 to 1912 as Chicago manager of the American Press Association.

The BOND Co., with offices at 84-86 High St., Boston, was organized May 1 by Harold L. Bond, for many years president of the Harold L. Bond Co., and more recently president of Waldo Bros. & Bond Co. Associated with him in the new organization are his two sons, Harold C. Bond and Lowell Bond. The company will serve as New England representatives of manufacturers of construction equipment and materials and as dealers in all kinds of contractors' tools. Included in the line of equipment handled are the products of the Novo Engine Co., of Lansing, Mich.

HAROLD H. PERRY, manager's assistant, Industrial Works, Bay City, Mich., sailed April 28 for England, where he will make an extensive study of locomotive and wrecking cranes.

A. FLETCHER MCCLINTOCK, Pacific Coast district sales manager for the Reading Iron Co., manufacturer of wrought-iron pipe, has been appointed assistant sales manager of the company, effective May 1. Mr. McClintock joined the company in 1919, after considerable experience in the sale of wrought-iron pipe, and shortly after was appointed district sales manager of the Pacific Coast territory with headquarters in Los Angeles.

W. C. MACDOWELL, formerly manager, mining sales department, Power & Mining Machinery Works of the Worthington Pump & Machinery Corp., has accepted the position of general sales manager of the Traylor Engineering & Manufacturing Co., Allentown, Pa.

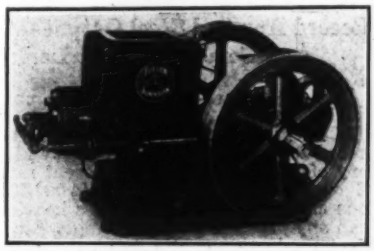
C. S. SALE, since 1918 assistant to the president, Railway Car Manufacturers' Association, New York City, has resigned to accept an appointment with the American Car & Foundry Co. His address will be 165 Broadway, New York City.

COMBUSTION ENGINEERING CORP., New York, announces the acquisition of the Quinn Oil Burner & Torch Co. W. R. Quinn, formerly president of the organization which bore his name, has become associated with the Combustion Engineering Corp. as manager of its fuel oil department.

Equipment and Materials

Gasoline Engine of 2½ Hp.

A 2½-hp. model with improved features has been added to the line of gasoline engines manufactured by the



Fuller & Johnson Mfg. Co., Madison, Wis. The operation of filling the fuel tank is facilitated by a new filler pipe, and uninterrupted service is assured by a double-throw switch which is now standard equipment on all sizes with magneto ignition. The magneto mounting is high and dry—away from oil and grease. Strength and rigidity have been leading considerations in the design of the wide, heavy flywheels, the crank-shaft and bearings.

Lightweight Bucket Increases Locomotive Crane Capacity

An extra ¼ cu.yd. of capacity in the handling of sand, gravel and broken stone by locomotive crane is provided for by a new design of special, lightweight clamshell bucket manufactured in three sizes 1, ¾ and ½ yd., by the G. H. Williams Co., Erie, Pa. On cranes ordinarily rated to handle a ¾-yd. clamshell the new 1-yd. bucket, weighing only 2,650 lb., may be used without overloading the crane and, in like manner, the ½-yd. size weighing 1,875 lb. and the ¾-yd. size weighing 2,100 lb., the manufacturer claims, may be substituted for heavier equipment having ¼-yd. less capacity. The weight of the extra ¼-yd. of material, it is pointed out, is amply covered by the crane's safety factor.

While the new bucket is designed especially for light weight and speedy operation its strength is guaranteed as

long as it is used for handling material such as sand and gravel, crushed stone, coal, etc. The bucket is built entirely of steel, including the sheaves. Power for speedy material handling is obtained by use of a 4-part closing line, giving twice as much power as buckets with only a 2-part line. The cable overhaul is cut down by a tandem arrangement of the sheaves on the power arm, further speeding up the operation.

Large Portable Riveting Machine

A 150-ton portable pneumatic riveter of 118-in. reach and 30-in. gap has been designed and built for the Niagara Falls Power Co. by the Hanna Engineering Works, Chicago. The riveter is primarily for fabricating the plates forming the volute of the casing and penstock for a 70,000-hp. hydraulic turbine. The volute plates vary in thickness from 1¼ in. at the entrance to ¾ in. at the end, with rivets of diameter from 1⅛ to 1 in. and 7,800 in number. The longest grip for the 1⅛-in. rivets is 5 in. The penstock is approximately 18 ft. in diameter with plates of 1⅛-in. thickness and about 110 ft. long. Three such penstocks are to be riveted. Since the volute and penstock are to hold water under a pulsating pressure of about

110 lb. per square inch, the character of this work must be of boiler quality.

The total portable weight of the riveter is 57,750 lb., and the weight of the frame, a one-piece steel casting, without spindle or riveting mechanism, is 33,000 lb. The largest portable machine previously built by the Hanna works weighed 25,000 lb. Mechanical power is necessary to move this riveter into the operating positions. The two motions, revolving and tilting, are performed by two reversible, close-quarters, air drill motors of approximately 2 hp. each, manufactured by the Chicago Pneumatic Tool Co. In order to minimize the power necessary to set the frame into the required position roller bearings and ball bearings are employed at all points of rotation.

The Hanna motion, or riveting mechanism, assures tight rivets being driven with every stroke of the piston, without any adjustment of the die screw to overcome the ordinary variation in length of rivets, thickness of plates, diameter of holes, etc.

Steel Sheetpiling—BETHLEHEM STEEL CO., Bethlehem, Pa., has published a new 25-page illustrated bulletin on Lackawanna steel sheetpiling of the arched web, straight web and bent web types. The bulletin gives dimensions, weights, and properties of all piling sections now being rolled, together with information on connections and splices.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Halt $10,000,000 College Building Program

High Costs Force Columbia University to Suspend Work in New York

SUSPENSION of the $10,000,000 program for the construction of dormitories, lecture halls and laboratories for Columbia University, in New York, was voted May 7 by the board of trustees as a result of present high costs for labor and materials in the metropolitan district. Similar action was announced May 6 in the case of the proposed $4,000,000 Hebrew Orphan Asylum in New York on which it has been decided to delay construction until prices recede from the high levels now prevailing in the New York district.

In announcing the decision of Columbia's trustees, President Nicholas Murray Butler expressed regret at the necessity for the action taken and stated that the program would be resumed as soon as the interests of the University and the public would permit. For the present, however, no further contracts will be let.

Another development in the New York building situation this week was the announcement by Michael J. Colleran, of the Building Trades Council, of a willingness to attempt to stabilize wages of skilled labor if manufacturers of building materials and building contractors would take similar action.

Car Loadings Break Record

The railroads continue to smash previous records for this time of year in the number of cars loaded with revenue freight, according to the Car Service Division of the American Railway Association, and are not far off from the peak loadings which ordinarily come in the fall of the year when crop movements are heaviest.

Loading of revenue freight for the week ended April 21 totaled 957,743 cars. This was not only the greatest number loaded during any one week since Nov. 17, 1922 but exceeded the corresponding week last year by 251,606 cars, when coal shipments were reduced by the miners' strike. The total also exceeded the corresponding week in 1921 by 253,111 cars, while it also exceeded by a wide margin the corresponding weeks in 1918, 1919 and 1920. The total for the week of April 21 was within 6 per cent of the total for the week of Oct. 15, 1920, which was the largest in the history of the railroads.

Loading of freight cars this year to date, compared with those of the two previous years, follows:

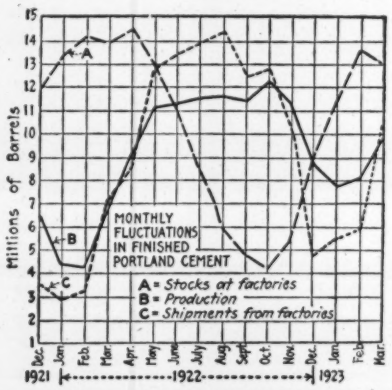
	1921	1922	1923
Month of January	3,380,296	2,785,119	2,823,759
Month of February	3,366,965	3,027,886	2,739,234
Month of March...	4,583,162	4,088,132	3,453,941
Week ended Apr. 7	895,767	706,013	694,881
Week ended Apr. 14	946,759	700,155	702,116
Week ended Apr. 21	957,743	706,137	704,632
Total for year to date.....	14,130,692	12,013,442	11,117,563

Production and Materials Stocks in Nine Cities

Record Iron and Steel Output—Lumber Cut Above Normal—Enough Cement to Meet Demand—Brick Shortage Near

Iron and Steel—April pig-iron production reached an average output of 118,252 gross tons per day, or the record for any single month in the history of the industry. The present rate of output is approximately 44,000,000 tons annually, or 4,000,000 tons heavier than any previous yearly average. Steel ingot production continues at the average rate of 45,000,000 tons per year, the rate reached in March, which was somewhat higher than the record average of March, 1920.

Lumber—Total production for the entire country as reported to the National Lumber Manufacturers' Association, reached 1,018,952,538 ft. for the four weeks ending Apr. 28, as compared with 970,773,211 ft. for the four weeks ending Mar. 31. April shipments totaled 1,017,521,210 ft., against 1,057,151,751 in March and orders reached 962,787,124 ft. compared with 942,776,090 ft. in March. Production now stands at 7½ per cent above normal, with shipments 108 per cent and orders 97½ per cent of normal production. Output was 7½ per cent below normal, May 12, 1922.



CEMENT STOCKS, PRODUCTION AND SHIPMENTS

Cement—A total of 25,669,000 bbl. were produced throughout the entire country during the first quarter of the current year, against 15,254,000 bbl. for the corresponding period in 1922, according to the Geological Survey. A total of 21,708,000 bbl. were shipped during the first three months of 1923, compared with 13,218,000 during the first quarter of 1922, leaving a reserve of 13,055,000 bbl. on hand Apr. 1, 1923, as compared with 13,848,000, on the same date last year. Shipments during 1922 were only about 80 per cent of mill capacity. Since then the capacity has been increased about 4,000,000 bbl. Requirements for 1923 are estimated at about 125,000,000 bbl., while the annual mill capacity is now close to 150,000,000 bbl., indicating that there should be no cement shortage unless unforeseen labor, fuel or transportation difficulties arise.

Brick—Reports received from 128 members of the Common Brick Manufacturers' Association of America, as of Apr. 1, show 3,796,000 fewer burned brick on hand, with an increase of 160,847,000 in orders on books, compared with the month preceding. With the greatly increased number of plants in the northern section now in operation, it is to be expected that production will show substantial increases.

San Francisco—Plenty of sewer pipe, crushed stone and hollow tile; big stocks of road oils, asphalt and reinforcing bars; fairly well supplied with lime, triangular mesh, structural steel and galvanized sheets; stocks of track supplies, metal lath, common brick and manila rope in good condition. Limited supplies, however, of rivets, nails, blue annealed and black steel sheets.

Denver—Plenty of all construction materials; stocks in normal condition.

Minneapolis—Stocks of all building materials reported ample. Face brick, somewhat short last month, has caught up, and demand is being met without delay. Cement situation good. Lumber stocks unusually large for the season; 100,000,000 to 110,000,000 ft. estimated as in Twin City yards. Much of this has been sold, so that there is no real surplus. Lateness of season has resulted in holding back deliveries with consequent accumulation in yards.

Detroit—Plenty of sewer pipe, and common lime; small reserves of cement and hollow tile. Plenty of cement, however, available at nearby mills. Several days required on large deliveries of hollow tile. Brick, lumber and asphalt stock conditions normal.

Chicago—Sewer pipe and lumber stocks in good condition. Fairly well supplied with cement, lime, hollow tile and structural steel. Shortage of brick. Limited supplies of asphalt. Prompt deliveries on cement and asphalt. Lime shipments in 24 hr. Brick and sewer pipe take two to three weeks. Hollow tile deliveries require seven to ten days; steel, two to seven days and lumber, thirty to sixty days.

New Orleans—Lumber mill stocks low; engaged chiefly in special cutting for railway car material. Plenty of other materials except asphalt and crushed stone.

Atlanta—About fifty cars each of lime and cement; forty to fifty cars of asphalt and between six and ten cars of structural steel. Plenty of pine lumber and common brick. Sewer pipe and hollow tile deliveries take four to five days.

CONDITIONS OF MATERIALS STOCKS IN IMPORTANT CENTERS

Stocks on hand in approximate figures, example: (Lumber, Minneapolis, 110,000,000 ft.); time required for delivery of carload lots to city job, example: (hollow tile Atlanta 4 @ 5 days); and stocks on hand in general terms, example: (brick, Chicago, shortage.)

	San Francisco	Denver	Minneapolis	Detroit	Chicago	New Orleans	Atlanta	New York	Philadelphia
Sewerpipe	Plenty	Del. 24 hr., local plant	Ample	Plenty available	Stocks in good condition	Ample	Del. take 4@5 days	Plenty small sizes	No surplus.
Cement	Mills running to capacity	Normal	Situation good	Small reserve; nearby mills	Fairly well supplied	Plentiful	About 50 cars	Output meeting demand	Stocks fair.
Lime	Fairly well supplied	Plenty	Enough	Stocks ample del. normal	Del. in 24 hr.	Sufficient	About 50 cars	Enough; demand increasing	Del. prompt; stocks good condition.
Common brick	Stocks in good condition	1,000,000	Plenty; face brick stocks caught up also	Supply normal in local yards	Shortage Del. take 2@3 wks.	Normal	Plenty	One months supply only.	No del. promised inside of 3 months.
Hollow tile	Plenty	Stocks normal	Sufficient	Local stocks small; del. take several days	Del. take 7 @ 10 days	Del. satisfactory	Del. take 4 @ 5 days	Scarcity	Stocks in fair shape.
Lumber	Big shipments continue	Shortage at mills	Unusually large for season 110,000,000 ft.	Moderate stocks in yards	Stocks in good shape. Del. take 30 @ 60 days	Stocks low. Mills have had no chance to accumulate	Plenty pine	Del. take 6 @ 9 weeks from mill.	Yards re-stocking rapidly.
Asphalt	Heavy native stocks	About 10 cars	Plenty	Normal del. good	Limited supply	None in stock	About 40 @ 50 cars	Heavy reserves in N. J.	Plentiful; shipments heavy.
Structural steel	Plenty of bars; low on rivets	Warehouse stocks sufficient	Well stocked	No shortage	Del. in 2 @ 3 days from stock		About 6 @ 10 cars	Slow mill deliveries	Pressure for deliveries unrelaxed

New York—Present demand for common brick heaviest on record. About one month's supply of Hudson River common brick in reserve; no other districts shipping into New York market. Pine lumber demand a bit slacker; stocks are somewhat limited and deliveries take six to nine weeks from mill.

Philadelphia—Lumber demand eased for the time being; yards restocking rapidly. Active demand for sewer pipe, paving stone and wood blocks; no surplus stocks in dealers' yards. Plenty of asphalt and manila rope. Fairly well supplied with cement, lime and hollow tile. Brick deliveries slow; no shipments promised inside of three months. Sand, gravel and crushed stone demand heavier than output; plants working at capacity.

Report on Freight Car Shortage

Shortage in freight cars on April 22 totaled 44,299 cars, which was a decrease of 4,285 since April 14, according to reports filed May 4 by the carriers with the Car Service Division of the American Railway Association. Of the total, 19,349 represented box cars, which was a decrease within a week of 2,613 cars, while there was also a decrease of 300 in the shortage of coal cars within the same period, which brought the total to 20,725 cars.

Surplus freight cars in good repair and immediately available for use if necessary numbered 11,062 on April 22, compared with 14,241 on April 14, or a decrease of 3,179. Surplus box cars in good repair numbered 4,071, an increase of 221 within a week, while surplus coal cars totaled 2,582, or a decrease of 677 within the same period.

Motor Vehicle Output for April Breaks Record

With a production exceeding 364,000 motor vehicles, all previous records were shattered by the automobile industry in April according to Alfred Reeves, general manager, National Automobile Chamber of Commerce. The April figures show a gain of 10,000 vehicles over those for March and are 66 per cent greater than for April of last year.

The outlook for the motor truck industry, Mr. Reeves stated, is the best in five years. Production in March was 62 per cent greater than February.

To Reduce Seasonal Unemployment

Through the Boston (Mass.) Building Congress, an organization composed of representatives of all elements of the building industry—building investment, architects, engineers, contractors, labor and material men—an attempt is being made to reduce seasonal unemployment, especially in repair work. Printed literature and diagrams are being distributed showing that in the building trades the average workman is out of employment 25 per cent of the time each year.

This condition is caused by concentration of demand in certain periods due largely to weather conditions. Much of this work, it is pointed out, could be done as well at other periods. It is suggested that the following types of work be done during the periods indicated: Roofing, in September, October, and November; painting, from December to April; Plumbing, from January to May; heating repairs and overhauling, during the spring; electric wiring, from September to January; masonry, carpentry, plastering and lathing, from Dec. 1. to April 1.

Announcing Engineering News-Record's Construction Barometer

In formally establishing the Business Side of Construction, in April, 1921, "Engineering News-Record" recognized the need for accumulating and presenting each week the current data of the construction industry.

It is now proposed to extract the essential information from the financial, industrial and construction news of the week and publish it weekly as a guide for the busy reader.

The first issue of this additional service will be found on the first page of the Construction News section. The aim of the CONSTRUCTION BAROMETER is to give in the smallest space and in the simplest terms sufficient significant information to permit of a ready understanding of the current situation and a possible forecast. Each week it will appear in its present location.

Structural Steel at New Record

A new high record in sales of fabricated structural steel was made in March, according to figures received by the Department of Commerce through the Bureau of the Census, in co-operation with the Structural Steel Society. March sales amounted to 95 per cent of shop capacity, as against 80 per cent in February and 53 per cent in April, 1922, the previous high record at the present shop capacity. Total sales reported for March by 153 firms, with a shop capacity of 220,790 tons per month, amounted to 210,716 tons, the first time that actually reported tonnage has exceeded 200,000 tons in any month.

Tonnage booked each month by 168 identical firms, with a capacity of 225,155 tons per month, is shown below, together with the per cent of shop capacity represented by these bookings. For comparative purposes, the figures are also prorated to obtain an estimated total for the United States on a capacity of 250,000 tons per month.

1922	Actual Tonnage Booked	Per Cent of Capacity	Estimated Total Bookings
April	198,228	88	220,000
May	182,112	81	202,500
June	163,615	73	182,500
July	154,547	69	172,500
August	153,797	68	170,000
September	144,519	64	160,000
October	129,816	58	145,000
November	109,435	49	122,500
December	130,853	58	145,000
1923			
January	168,227*	75	197,500
February	178,822†	80	200,000
March	210,716‡	95	237,500

*Reported by 166 firms with a capacity of 224,455 tons.
†Reported by 166 firms with a capacity of 224,755 tons.
‡Reported by 153 firms with a capacity of 220,790 tons.

Gain in Lumber Production

Based on reports from regional associations the National Lumber Manufacturers' Association reports the following comparison of lumber movement for the first 17 weeks of 1923 and for the same weeks of 1922:

Year	Production	Shipments	Orders
1923	3,811,336,293	4,322,672,838	4,530,503,789
1922	3,041,220,534	3,087,217,808	3,384,578,392
1923 Increase	770,115,759	1,235,455,030	1,145,925,397

Decision in Metal Trim Case Expected This Month

Washington Correspondence

Lively interest is being displayed regarding the decision which the Joint Board for Jurisdictional Awards in the Building Industry will render in the so-called metal-trim case. The decision is expected at the next meeting, the latter part of May. While the metal-trim case involves comparatively little money the decision will have an important bearing on the future of the jurisdictional awards board.

The issue is between the carpenters' union and the sheet-metal workers' union. Previously, the board decided that metal-trim work belonged to the sheet-metal workers. The carpenters refused to accept this ruling, and several expensive strikes in the building trades have resulted. At its last meeting the board re-opened the case.

The case is felt to present unusually delicate features for the board because of its previous ruling and the attitude of the conflicting unions. If the new decision is not accepted by the losing side it is feared that the entire authority of the board may be placed in jeopardy, as adherence to its decisions is voluntary.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of May 3; the next, on June 7.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products:									
Structural shapes, 100 lb.	+$3.64	$4.30	$4.50	+$3.40	$3.55	$4.20	$3.85	$4.10	$3.75
Structural rivets, 100 lb.	+4.40	5.00	5.25	3.75	4.25	5.15	5.00	+4.75	6.00
Reinforcing bars, ¾ in. up, 100 lb.	+3.54	4.25	3.15	+3.32½	3.45	3.85	3.40	4.10	3.50
Steel pipe, black, 2½ to 6 in. lap, discount	49%	50%	45%	59½%	53-5%	36%	+35.2@47.6%	30.15	32.76
Cast-iron pipe, 6 in. and over, ton.	58.50	—56.00	+61.00	+60.20	60.50	+69.00	60.00	+70.00	60.00
Concreting Material:									
Cement without bags, bbl	2.70@2.80	3.25	2.25	2.20	2.39	2.85	2.71	2.90	2.68
Gravel, ¾ in., cu.yd.	2.25	1.90	2.25	—2.00	1.75	1.90	2.15	1.25	1.50
Sand, cu.yd.	+1.25	1.24	1.90	—2.00	1.00	1.00	1.50	1.25	1.25
Crushed stone, ¾ in., cu.yd.	1.75	2.00	2.50	—2.00	2.25	3.50	2.15	3.00	1.90
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	65.00	+42.00	53.00	60.00	+46.75	+44.00	41.00	31.00	90.00
Lime, finishing, hydrated, ton.	+18.60	+23.50	22.50	20.00	25.50	24.00	22.00	24.00	21.00
Lime common, lump, per bbl.	3.00@3.25	+1.50	2.50	1.50	1.25	2.70	1.75	2.80	11.00
Common brick, delivered, 1,000	23.50	+14.00	13.10	11.00	17@19	12.00	15.00	13.00	16.50
Hollow building tile, 4x12x12, per block	Not used	.0893	.115	.1032	.0836	.065	....	.11	.115
Hollow partition tile 4x12x12, per block	+.1573	.0893	.115	....	....	.065	.108	.11	....
Linseed oil, raw, 5 bbl. lots, gal.	1.16	—1.26	1.42	+1.35	—1.29	+1.44	1.24	.86	1.15
Common Labor:									
Common labor, union, hour.	.75	.35	.....	.....	.....	.50@.55	.56¼	....	.....
Common labor, non-union, hour.	.....	.30	.30@.50	.72½	.35@.50	.35@.50	.50	+.50@.62½	+.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Labor—Concrete laborers' rate, 81¼c.; building laborers, 75c.; minimum for pick and shovel men, 50c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in iron bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Steel pipe, per 100 ft. net.

Montreal quotes on Douglas fir. Sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 98.03). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½-in., $32.76; 6-in., $108.

Changes Since Last Week

Despite weaker undertone of pig-iron market, cast-iron pipe advanced $2 in Chicago and Denver and $4 in Dallas during last two weeks. Atlanta, however, reports drop of $2 per ton, in week.

Recent steady advance in steel mill prices, reflected in higher warehouse quotations in New York, Chicago and Seattle, on shapes, rivets and bars.

Mill prices, however, easier at present, particularly in steel bars. Structurals and reinforcing bars more quiet. Dropping off in demand for oil storage tank-plates and car material. Plates quoted at $2.50@$2.65 per 100 lb., f.o.b. mill, for deferred deliveries; earlier shipments commanding $2.75. Shapes now $2.50@$2.60, shipped at convenience of mill; $2.70 named where deliveries are specified. Bars quoted as low as $2.40 for indefinite delivery; $2.65 and higher on orders involving earlier shipping specifications.

Sand advanced 25c. per cu.yd. in New York, during last two weeks, owing to higher production costs. Chicago, however, reports reduction of 25c. per cu.yd. in sand, gravel and crushed stone.

Hydrated finishing lime advanced 50c. in Atlanta and $1.50 per ton in New York, during last two weeks. Brick also reported higher in Atlanta; prices stable elsewhere.

Lumber developing a stronger market. Yellow pine timbers up $2 in Atlanta; Douglas fir advanced $1 in Minneapolis and $1.25 per M. ft. in Denver.

Linseed oil rose 3c. in Denver and 10c. per gal. in Chicago. Decline of 5c. reported in Minneapolis and 2c. per gal. in Atlanta, during week.

The wage schedule for the following trades has been adopted in Montreal for the balance of the current year: painters, 60c.; stonemasons, 90c.; plasterers and bricklayers, $1 and common laborers, 30c. per hour.

Granting of wage demand to brick handlers in the Hudson River District, supplying the New York market, will bring the cost of unloading brick barges to $1 per M. or $25 per day per man. New York price remains unchanged at $20 per M., alongside dock, despite increased cost in handling.